C. S. Sherrington

SELECTIONS

Cambridge

FROM

THE RECORDS

OF THE

MADRAS GOVERNMENT.

PUBLISHED BY AUTHORITY.

No. XXXII.

REPORT OF A COMMITTEE

ON A PLAN

FOR CLEANSING THE DRAINS OF

BLACK TOWN.

MADRAS:

PRINTED AT THE ASYLUM PRESS, BY WILLIAM THOMAS.

1856.

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CONTENTS.

Page

Proceedings of a Committee appointed by Government in their Minutes of Consultation, under date the 25th November 1851, to examine and report upon a Plan submitted by Captain Boulderson, for cleansing the Drains of Black Town, by means of Sea water pumped up by a Steam Engine... 1

Memorandum of the Apparatus required for Major Boulderson's scheme. 9

Letter from the Military Board to Government, dated 26th April 1853. 10

APPENDIX.

Appendix A.—Memorandum by Lieut. Col. A. T. Cotton, Chief Engineer and Member of Military Board, on the rebuilding of the Northern Tunnel, &c., &c., dated 31st August 1852. 25

Appendix B.—Letter from the Military Board to the Medical Board, dated 20th October 1852... 32

Appendix C.—Letter from the Military Board to the Chief Magistrate and Superintendent of Police, dated 8th November 1852. 34

Appendix D.—Letter from the Military Board to the Medical Board, dated 8th November 1852... 38

Appendix E.—Letter from the Military Board to the Superintendent of Gun Powder Manufactory, dated 5th November 1852. 38

Appendix F.—Letter from the Military Board to the Superintendent Gun Carriage Manufactory, dated 5th November 1854. 40

Appendix G.—Letter from the Superintendent of the Gun Carriage Manufactory to the Military Board, dated 10th November 1852... 40

Appendix H.—Letter from the Superintendent Gun Powder Manufactory to the Secretary Military Board, dated 7th Nov. 1852. 41

Appendix I.—Letter from the Military Board to the Marine Board, dated 5th November 1852... 42

Appendix J.—Letter from the Marine Board to the Military Board, dated 9th December 1852... 43

Statement shewing the annual cost of water, &c., from 1st January 1851 to 30th January 1852. 44

Appendix K.—Memorandum from the Military Board to the Chief Engineer, dated 29th November 1852...... 44

Appendix L.—Letter from the Medical Board to the Military Board, dated 31st December 1852... 44

Appendix M.—Sanitary Report on the 4th District of Madras, dated 5th May 1848... 47

Page

Appendix N.—Report on the Sanitary condition of the 2d District, dated 6th May 1848... 49

Appendix O.—Letter from the Superintending Surgeon to the Chief Magistrate and Superintendent of Police, dated 18th May 1848.... 54

Appendix P.—Letter from the Surgeon, 1st District to the Superintending Surgeon, Presidency, dated 19th November 1852. 56

Appendix Q.—Report from the Acting Surgeon 4th District, in reference to Water and Drains... 61

Appendix R.—Report from the Surgeon 3d District, to the Superintending Surgeon, dated 13th December 1852... 63

Appendix S.—Memorandum on the Honorable Company's Water Works at Madras, dated 22d January 1852... 69

Appendix T.—Memorandum by Lieut. Col. A. T. Cotton, Chief Engineer and Member Military Board, in continuation of that dated 31st August 1852... 75

Estimate of cost and charge for Water in Madras... 85

Appendix U.—Memorandum on the Adyar Basin, by Lieut. Col. A. T. Cotton, Chief Engineer, dated 22d April 1852... 87

PROCEEDINGS OF A COMMITTEE APPOINTED BY GOVERNMENT IN THEIR MINUTES OF CONSULTATION, UNDER DATE THE 25TH NOVEMBER 1851, TO EXAMINE AND REPORT UPON A PLAN SUBMITTED BY CAPTAIN BOULDERSON FOR CLEANSING THE DRAINS OF BLACK TOWN BY MEANS OF SEA WATER PUMPED UP BY A STEAM ENGINE.

PRESIDENT.

Major J. T. SMITH, Engineers.

MEMBERS.

Major F. C. COTTON, Engineers, | Captain G. C. COLLYER, Engineers.

Para 1. Agreeably to the instructions contained in the Minutes of Consultation of Government above cited, the Committee have carefully considered the project submitted by Captain (now Major) Boulderson, *for cleansing the drains by means of a supply of sea water pumped in by a Steam engine;* and as they are unanimously of opinion that it is not advisable that the Government should carry it into execution, they deem it their duty to submit the following Statement of their opinions, for the consideration of the Right Honorable the Governor in Council.

2. Upon enquiring into the nature and extent of the evils which Major Boulderson's scheme is designed to remedy, they find that they are chiefly confined to the nuisances arising from the condition of the main sewer.

3. In order to a clearer explanation of the subject, it may be as well here to mention, that Black Town is built on two ridges, between which the main sewer lies; and the whole of the drains are comprehended in three classes, as follows:—1st, the primary or street drains* the majority of which run north and south, along the ridges, and parallel with the main sewer; 2ndly, the secondary drains, down the ridges, thus leading to the main sewer; and 3rdly, the main sewer.

* There are no house drains properly so called. There is generally a channel from the premises of each house, laid without much attention to slope, and terminating in an orifice in the face of the front wall, down which the liquid refuse trickles presenting an object offensive to both sight and smell.

4. The evils proposed to be remedied are, as above stated, chiefly connected with the main sewer. Whatever nuisances may be caused by the primary or street drains, they are untouched by the scheme submitted for our opinion, the proposition being to leave them exactly as they are.

5. With regard to the secondary drains, the Committee have reason to think after some enquiry, that but a very small proportion of the complaints attach to them, and there ought to be no complaint at all, because as they run down the slopes, and, in general, have a sufficient inclination, there is no reason why they should not, if properly constructed, be maintained at all times in a perfectly inoffensive state, without any artificial means.

6. It is, therefore, in the main sewer alone that the benefits derivable from Major Boulderson's plan are to be sought, and here the Committee regret to state that, after the most attentive consideration of the subject, they are apprehensive that disappointment may be met with.

7. The evils of the main sewer are caused by two essential defects, viz., the want of inclination in its bed, and the want of a free out-fall at its mouth, which is below the level of high water.* No amount of pumping, in the manner proposed, will remedy, or even palliate these defects. Major Boulderson's plan contemplates the circulation of a stream from the heads of the secondary drains into the sewer. By this the secondary drains may be kept clean and inoffensive, but they ought to be so without artificial washing. The evil of the main sewer will not be corrected thereby, because, for want of slope in its bed, the sewage, however diluted, would not flow with sufficient velocity to keep clear of deposit, even were the mouth constantly open; and for want of outlet, the corrupt mass is obliged to be kept for many hours in a state of stagnation, deposit, and decomposition.

8. The mere circumstance of dilution of the sewage, the Committee think, cannot be depended upon as certain to remove the annoyances occasioned by the main sewer. Indeed, there are some peculiarities connected with its condition, which tend to create a doubt whether the evils may not even be increased by augmenting the bulk of fluid.

9. At present, in consequence of the slight fall the main sewer does possess, the whole of the filthy stream dribbling into it from the secondary drains, slowly finds its way to the two mouths, north and south, where the stagnation, ferment, and decomposition, go on at a distance from the inhabitants. If the main sewer be, as Major Boulderson proposes, daily filled, it is

* The form of the sewer is objectionable, and in one part it has a reverse slope.

to be feared that the nuisance of decomposition, and the generation of noxious gases, which would then take place along the entire length of the sewer, might lead to more inconvenience than is now experienced. This evil is complained of in the low lying districts of London, although, in addition to the great advantage of a cold climate, (as opposed to chemical decomposition) the drains are washed out with a quantity of water from the Thames "probably at least from 8 to 10 times greater than the ordinary sewage flow" and the effect of the gradual filling of the sewer in developing the nuisance is clearly exhibited in the following extracts from the evidence of Mr. Lovick, the Officer in charge.

Report of General Board of Health, Appendix II, page 132.

"You of course have had to flush the sewers in the Surrey and Kent "district, and have observed there the effect of the intermittent discharges of "the drainage matters, which are backed up and kept within the district "during high water. In the discharge of the sewer there, is not the supernatant sewage water decanted off, leaving the matter deposited, and what are "its effects?

Report of General Board of Health, Appendix II, page 131.

"Yes.—From the drainage matter in "this district being locked in for many "hours in each day, a very large proportion is deposited, and, when the outlets "become free then the liquid portion, with but a slight amount of solid matter "is decanted off, or flows into the Thames. And, as the reservoir sewers "become full, the foul gas is expelled from them through every opening, into "the public thoroughfares, and into private houses. And the generation of "foul gas is quickened by the stagnation of the drainage, being continually "formed, and continually expelled, by the progressive accumulation, so that "not only are mechanical difficulties created, but health is jeopardised by this "arrest of the flow." P. 131.

10. The evil would not be remedied by the fact of the main sewer being arched over, as will be seen by the following Statement of the Commissioners. "Loud demands have been made, that long "lines of open ditches and sewers containing stagnant deposit "should be arched over, but this measure, as now executed, though it may "mask, actually aggravates the evil, at an expense often double that which, "with a proper combination of works, would suffice for its prevention."

Report p. 227.

11. From the experience above detailed, it appears to the Committee to be a matter of some doubt whether any material diminution of the evils caused by the main sewer would be obtained by the agency of Major Boulderson's proposed scheme; and, adverting to the entire system of drains, and the incon-

veniences experienced from them, that the only part certain of improvement thereby would be the secondary drains, in respect of which the least inconvenience is now felt; and where, as before observed, but for defects of construction capable of remedy without other aid, no inconvenience would be felt at all.

12. Although the Committee cannot, for the reasons above stated, approve of Major Boulderson's project, they have given it their most attentive study, and they have the honor to subjoin a Memorandum specifying the description of engine, pumping apparatus, and water pipes, suited to carry it into operation in the most efficient manner.

13. The true and only complete remedy for the evils of the main sewer, as well as of all the other drains, is an improvement in their form and capacity, and their arrangement upon proper slopes, so that the sewage shall never be allowed to stagnate; a continuous flow being kept up from the moment of its entrance, to that of final discharge. The realization of this principle would probably require the aid of steam power, but not for the purpose, nor to the extent necessary by Major Boulderson's scheme. It has been satisfactorily proved by H. M. Sanitory Commissioners, that the most perfect, as well as the most economical system is, to lead the sewer down at a proper inclination to an artificial out-fall, and there, if necessary, pump up its contents for discharge; and it is agreed that the cost of sufficient pumping applied in this way is "greatly below" that of sufficient flushing through the same districts.

Report p. 221.

14. These principles are new, and their publication has placed the science of hydraulics, as applicable to the drainage of cities, upon a new basis. Had the Committee not been possessed of H. M. Sanitory Commissioner's very valuable report, lately transmitted to Madras by the Honorable the Court of Directors, they would not perhaps have been inclined to speak so decidedly in condemnation of Major Boulderson's project.

15. The report above alluded to has so clearly established, that in all cases the water supply of the inhabitants of a city, and its drainage ought to be treated in combination, that it appears to the Committee to be their duty respectfully to point out to Government the great importance of not separating them unless the impossibility of the combination were proved. As regards the vital influence of an abundant supply of fresh water to the sanitory welfare of a town, there can be no difference of opinion, but in the present instance, as it has been apprehended that the supply would be precarious and uncertain, the Committee would suggest that a full and careful enquiry should be made into the sources and best means of procuring fresh water, and a report, based upon a

survey of the localities,* obtained as to the feasibility of guarding against the deficiency in the hot season, together with a notice of the quality of any supply procurable from the tanks as compared with the best now in use and the ordinary produce of the wells. They are of opinion that the result of such an enquiry would most probably have the effect of removing the doubts which at present interfere with the bestowal of this great blessing on the people; and it may be remarked, that while the effect of such a supply bestowed at the present juncture would be to realize more than all the advantages contemplated in pumping up water from the sea, in as much as it would circulate through *all*, instead of a* part only of the drains, the effect of such a boon conferred subsequently to the completion of the plan now under consideration, would be to neutralize its action, and necessitate its abandonment.

* Madras wells, Palar, Cortelar, Adayar, Rivers. Chembrumbaucum, Red Hill, and other Tanks.

* ¼th.

16. With the information thus obtained, the Committee would strongly recommend that the entire subject of the water supply and drainage of the Black Town should be thoroughly studied in all its details, with a view to the reformation and re-establishment of the whole upon sound principles. This proposition may perhaps suggest an alarming idea of the magnitude and expense of the undertaking, but it must be remembered, that though it is essential that all the necessary works should be previously planned and determined upon, yet the fact of doing so, will not only not add to the actual outlay, but in all probability greatly diminish it, by preventing useless constructions; and if, as it is probable, it should appear that a large proportion of the existing drainage needs to be built anew, this circumstance would merely indicate the necessity for a reform which is actually in progress, but which being carried on in connection with the former system, may perhaps, it is feared, be found to be carried on in vain.

17. It is the more necessary that the subject should be thoroughly considered beforehand; because no appreciable good can be done except at a considerable expense. For instance, the Committee roughly calculate the cost of establishing Captain Boulderson's scheme, inoperative although it be upon three fourths of the drains, at little short of 2 lacs of Rupees, and they do not think that the complete establishment of this part of Madras in water supply and drainage on correct principles would cost much more, while, it is to be remarked that even the latter would be by no means the whole expenditure, as Black Town is only a part of the city, of which there are other parts equally or more urgently claiming consideration.

18. The Committee would beg very respectfully to bring to the notice of

the Right Honorable the Governor in Council, that in order to ensure success in the preparation of a well considered and comprehensive system of water supply and drainage for this very extensive and populous city,* it appears to them indispensable that the undivided attention of at least one officer should be given up to it.† This subject has been so prominently brought to notice by H. M. Sanitory Commissioners, that the Committee need not do more than refer to their report and state their entire concurrence in their views.

* 700,000.

Report p. 300.

19. Such a plan the Committee need not say it is quite beyond their power to prepare, while they are individually occupied in their own more immediate duties, but they consider it their duty to offer the following remarks and suggestions, based on information gathered in the course of their investigations, which though necessarily imperfect, have not been altogether superficial.

1st. It appears that a scheme for improving the drainage of Black Town will not benefit more than one third of Madras, and that, as Mr. Elliot the Chief Magistrate states, the portion at present best provided for already.

2d. That the pipe drainage so strongly recommended by H. M. Sanitory Commissioners seems peculiarly well suited to the chief portion of Black Town, and also to the other low lying districts of Madras.

3d. That the discharge from pipe drainage would be less impeded by the action of the surf than that from large sewers.

4th. That an additional supply of good water in all parts of Madras is a great desideratum.

5th. That some additional supply may be had from the present wells on the north side of Black Town.

6th. That a large further supply of the same excellent water might be had from wells sunk at a spot three miles north of the present wells.

7th. That a liberal supply of water brought into convenient positions for the benefit of the inhabitants of Madras, would lead to its use by the people in such quantity as to render the sewage sufficiently fluid for pipe drains, if it be not so already.

8th. That fresh water to a considerable extent might be collected in a tank formed in the valley of the Adayar, the ground being peculiarly favorable.

† An establishment of one or two Surveyors, Draughtsmen and Estimate maker, besides three or four Lascars would be necessary also.

9th. That the tract of ground south of the Adayar would probably supply the adjacent section of Madras with water of the same quality as is now procured from the wells in the north of Black Town.

10th. That nothing would so effectually secure Madras against the risk of an insufficient supply of water as a tank in the neighbourhood supplied by a river.

11th. That the most certain river is the Palar, whose waters already come to Madras in small quantities, by indirect channels.

12th. That the Adayar river has never been a year, the Committee believe, without water sufficient to fill such a tank as is required, and there is reason to think that either in its bed, or elsewhere in the neighbourhood of Madras, there would be no difficulty in forming a tank of capacity sufficient to supply Madras for two years if necessary.

13th. The Committee have learnt that it is in contemplation to build an open brick sewer, in lieu of the stagnant ditch joining the cesspool on the northern esplanade with the Cooum river. This work as it appears to them, might be dispensed with, and the ditch filled in; whereby a considerable expenditure might be saved, and a complete remedy for the nuisance substituted for a very questionable one.

14th. The Committee beg respectfully to draw the attention of Government to two points, which though indirectly connected with the subject of their report, they trust they will be excused for noticing—1st, whether it be not very undesirable that the tract of land on the north side of the Black Town walls should be permitted to become gradually converted into native parcherries, by the increasing settlement of many thousands north of the Monegar Choultry. They are apprehensive that the gradual extension of crowded dwellings on that side, may ere long have a sensible effect upon the purity of the supplies of fresh water gathered from the sand between Trivatoor and Madras. They think it would be very desirable to keep that neighbourhood free from dense occupation, as much as possible.

2ndly. The Committee finding that the greatest cause of complaint against the drainage of Black Town is the stench from the lower end of the southern main sewer, and being of opinion that the evil might in a great degree be overcome by cheap and simple means, strongly recommend that the remedy should be applied at once, even though it should entail a small outlay on a work which would be useless if the drainage they suggest is adopted; as the preliminary measures proposed cannot be completed for some time, and the

evil is one which affords good ground for complaint, and a necessity for immediate remedy.

20. The portion of the sewer alluded to was built with a reverse slope towards the land, under the impression that the sea water would flow in during a part of the day and wash the drain, but experience has proved the supposition erroneous. The drain cannot be left open for the admittance of the sea water, as in that case, the sand enters with it, and chokes the passage—the only effect being that a reservoir is formed, in which a vast quantity of sewage is collected. The sewer is never emptied, and the fluid when discharged appears, in consequence, to be far more offensive than it otherwise would be. This seems a natural result of such a body of sewage remaining to decompose throughout the day; and the comparatively inoffensive discharge from the northern drain which has no reverse slope, confirms us in our belief that it is so.

21. The remedy for this would be to raise the floor of the sewer to such a direct slope as the levels will admit of; which in the opinion of the Committee would not diminish the capacity of the drain so as to reduce its efficiency.

The Committee would finally recommend that the temporary improvement just noted be immediately made, and enquiries instituted as to the best means of procuring and distributing a supply of fresh water for the use of the town at the rate of 5,000 to 7,000 cubic yards per diem.

J. T. SMITH, Major,
FRED. COTTON,
G. C. COLLYER, Bt. Captain. } *Engineers.*

FORT ST. GEORGE,
9*th Feby*. 1852.

MEMORANDUM OF THE APPARATUS REQUIRED FOR MAJOR BOULDERSON'S SCHEME.

One 40 horse power steam engine adapted to a forcing pump and intended to raise sea water from a few feet beneath its own level to a total height of 40 feet above the canal level at the rate of about 8 cubic feet per second; and also by a separate Mechanism, worked within the same building [to be constructed to suit the engine and apparatus*] to work a bailing scoop, or other pump suited to lift sewage to a height varying at different times from 4 to 12 feet, or if it can be done without inconvenience from 4 to 20 feet at the rate of 2½ cubic feet per second. The height of 12 feet has been taken in estimating the power of the engine (working night and day) at 40 horses, if a greater height can be conveniently arranged as the lift, a slight addition to the horse power may be allowed for, if thought necessary.

In addition to the steam engine, pumping and lifting apparatus, there will be required the following pipes :

1000 feet of 8 inch pipe with one junction piece carrying on each side a branch service pipe of 3 inch drain, a few inches long, furnished with turn cock.

1500	feet	12	inch	do.	with	3	junction	pieces.
3000	feet	14	inch	do.	with	6	do.	do.
1400	feet	15	inch	do.	with	2	do.	do.
1500	feet	16	inch	do.	with	2	do.	do.
2800	feet	17	inch	do.	with	4	do.	do.
1200	feet	19	inch	do.	with	2	do.	do.
4500	feet	20	inch	do.	with	0	do.	do.
1200	feet	21	inch	do.	with	2	do.	do.
1000	feet	22	inch	do.	with	2	do.	do.
1000	feet	23	inch	do.	with	2	do.	do.
1000	feet	24	inch	do.	with	2	do.	do.
2500	feet	25	inch	do.	with	0	do.	do.

ALSO.

2	sluice	cocks for	pipes	25	inch	drain.
1	do.	do.	do.	20	do.	do.
1	do.	do.	do.	24	do.	do.
1	do.	do.	do.	17	do.	do.
2	do.	do.	do.	8	do.	do.

All these pipes of whatever material composed ought to be capable of standing on hydraulic pressure of 50 or 60 feet.

* NOTE.—Such as that designed by Mr. W. F. and described in Mr. Weales' rudimentary treatics on the drainage of districts and lands, page 72.

FROM THE MILITARY BOARD, TO LIEUTENANT GENERAL THE RIGHT HONORABLE SIR HENRY POTTINGER, BART, G. C. B., GOVERNOR IN COUNCIL, &C. &C. &C.

Right Honorable Sir,

The Minutes of Consultation, of Government quoted in the margin, conveyed to us the sanction of the Honorable Court for an expenditure of Rupees 73,925-0-1 upon two objects connected with the drainage of Black Town, viz.:—

No. 1077, dated 25th Nov. 1851.

1st.—Reconstructing that portion of the main sewer of Black Town which traverses the north Esplanade of the Fort, and through which the sewerage of Madras discharges itself into the sea, Rupees 27,670-12-4.

2d.—Constructing a masonry channel in the place of the ditch as a surface drain for that part of the Esplanade, Rupees 46,254-3-9.

2. On receipt of these orders this Board invited tenders for the execution of these works on contract ; but before completing agreements for their execution, it was necessary to determine how to dispose of the sewerage while the alterations to the Tunnel were in progress ; as those alterations were of a nature to involve it's disuse during that time, viz., for a period of 18 months.

If, during the operations on the Tunnel, we were to keep the west ditch open and allow the whole sewerage of this large town to flow from the main drain by that ditch into the Cooum ; that river becoming the receptacle of all the filth, would carry the effluvia throughout the whole of Madras. And independently of the stench which would be insufferably offensive throughout the Fort, the town, and all Madras, it cannot be doubted that the effect on the health of a locality so thickly peopled would be exceedingly prejudicial ; and lasting for so long a time it might very likely give rise to destructive epidemic. The only alternative that occurred to us was to deviate from the sanctioned design so far as to construct an entirely new Tunnel alongside of the present one, so that the latter might continue in use till the new work should be completed. But as this would involve a material augmentation of the cost, inasmuch as the sanctioned estimate contemplates rebuilding only the superstruction of the Tunnel on the old foundation and flooring, and as at the best, this work would only be a mere partial attempt to correct a system of works already pronounced by a Committee of Engineer Officers to be defective in principle, we

deemed it expedient to defer further consideration of this important question, till our colleague the new Chief Engineer Col. A. Cotton, should take his seat at the Board.*

3. On the Chief Engineer assuming charge of his office in June 1852, the papers were put into his hands, and in a Memorandum dated 31st August, he laid his sentiments before the Board. The paper will be found in Appendix *A*, and we beg to recommend it to the attentive perusal of your Excellency in Council. Its purport in brief is as follows :—

In the first place the Chief Engineer expressed the opinion, entirely in concurrence with that at which the other members of the Board had previously arrived, that the reconstruction of the main sewer as sanctioned was impossible. He then proceeded to take a general view of the various objects, sanitary and other, which had been contemplated for the improvement of Madras, several of which have already been placed before this Board by the Government, and showed how intimately they are all connected (with the exception of the survey) ; pointing out how all have failed hitherto—as remarked before, by the Committee of Engineer Officers appointed in 1851 to report on a project for the cleansing of Black Town,—for want of an Officer unincumbered with other duty, to enter into a full investigation of these important questions.

4. The Chief Engineer then adverts to the scheme proposed by the same Committee, for effecting the cleansing of Madras by means of a reservoir of water to be formed by damming up the Adyar river above St. Thomas' Mount, and shows how such a reservoir with subordinate works, would secure all the objects already adverted to, besides others of not inferior moment ; and points out not only that this may be done at a cost which must be pronounced insignificant in comparison with the results to be obtained even if the capital were to be wholly sunk, but also that in fact the outlay would yield a considerable return.

5. These objects are detailed in the 8th para of the Chief Engineer's Memorandum. We will briefly recapitulate them here.

1st.—Securing a full supply of wholesome fresh water, not only for Black Town but for all the suburbs and out-villages of the Presidency, numbering a population of 700,000 persons.

*The plans and estimates were framed and submitted to Government several years ago, before any of the present members of this Board were connected with it ; the omission to provide means for disposing of the sewerage during the reconstruction of the Tunnel must have been owing to this one work being part of a more extensive scheme for the drainage of Madras to be executed partly under Government, and partly under the Assessment department.

2d.—Thoroughly cleansing Black Town, Triplicane, and all the other Towns and Villages of Madras.

3d.—Keeping the Cooum and Adyar Rivers always sweet and pure.

4th.—Irrigating the whole of the lands of Madras so far as that might be required, viz., a full supply for the rice lands, and the smaller supply necessary for plantations, gardens, compounds, &c., and this with better water and at a far cheaper rate than that at which it can now be done from wells.

5th.—The north Canal (Cochrane's) would be kept always full and capable of navigation without obstruction.

6th.—A line of navigation would be formed from beyond the Mount along the deep bed of the long tank and the Nungumbaukum tank to the Cooum river and the north Canal ; whereby the commodities brought in by the latter would be distributed to all parts of the Presidency, instead of requiring to be unloaded at the furthest corner of Black Town.

7th.—Granite could be brought from the Mount into Madras at a very cheap rate, and would be available for many purposes ; among them for making the roads, being a much more durable material than the iron stone now used. It could also be laid down at the Beach for the construction of groins at about one-fourth of the present cost ; and ultimately when the construction of a Pier or a Breakwater shall be resolved on, this resource will be of great importance.

8th.—The Canal along the deep beds of the two tanks above specified would furnish irrigation for all the land now watered by those tanks. It would therefore be unnecessary to fill them higher ; and the whole of their extensive shallow beds, of which a considerable part is already cultivated when the water subsides, might be watered from the new reservoir, or would be available for building.

The sources of income calculated upon in connection with the works are the following : payment for water used for irrigation, and if thought expedient, for that supplied for domestic use, and a toll on the Canal, and a rate for the use of water power. Further details of the plan will be found in paras 9 to 12 of the Memorandum.

6. On receiving the Memorandum of the Chief Engineer, the Board fully concurred with him that the various subjects connected with local improvement ought to be taken up together ; and his project for effecting them all, commended itself strongly to their judgment as well deserving that full

investigation which he proposed. It seemed proper however, before submitting to Government any recommendation to that end, to make further enquiry on some points on which information was within the Board's reach, especially as to the sanitary condition of Madras under existing circumstances, and the probability of improvement by means of a full supply of water for domestic use and for cleaning the sewers.

7. With this view we addressed the Medical Board, requesting such information as they could afford, as to the amount of disease now prevailing at the Presidency and due to removeable causes; and whether a more effectual cleaning of the sewers be necessary as a means of preventing disease. We also wrote to the Chief Magistrate soliciting his opinion on similar points, and to the Superintendents of the Gun Powder and Gun Carriage Manufactories, requesting to know to what extent water power could be made use of in those Establishments respectively, to economise labour. We also endeavoured to ascertain from the Marine Board what benefit would be likely to accrue if fresh water for supplying the shipping in the roads were laid on at the very Beach. These letters, and the replies received to them will be found among the printed papers accompanying.

8. The Medical Board transmitted with their reply six reports on the subjects in question, being from the Surgeons of each the Presidency Districts, and from the Superintending Surgeon; three of them written in consequence of our letters to the Medical Board, and the others a few years ago, and already on the records of the Board. These documents, corroborated as they are by the opinion of the Medical Board itself, fully establish the necessity of an increased supply of water, as one important means of removing the present abounding causes of disease and mortality in all the populous localities of Madras. We will here make only a few brief extracts from them; but we beg to recommend the whole series as well deserving attention, in connection with the sanitary improvement of Madras.

9. Mr. Cole reporting on the 4th District, in May 1848, calls particular attention (Appendix M) to the very offensive nullah north of St. Thomé, which in fact forms the only receptacle for the densely peopled and filthy Mahomedan suburb of Triplicane. The stream is insufficient to keep the mouth of the nullah open except during the rains, so that at other seasons the sewerage accumulates in the shallow basin within, and it is well known that during the dry season the stench becomes so excessively offensive that the road in the neighbourhood is hardly passable, and an artificial opening is sometimes made, so as to empty the reservoir into the sea. Mr. Cole proposes a means of abating this pestilential nuisance, which would be expensive, whilst its success seems

more than doubtful ; but a command of water would secure the object effectually, as it would keep the bar open, and the filth of each day would be discharged immediately. Speaking of the drains within Triplicane, Mr. Cole further says—" An increase in the number of Scavengers is much called for, and " a more frequent and complete clearing of the drains in these localities is " much required." A good supply of water would effect this clearing much better than any number of Scavengers.

Dr. Cleghorn writing of the same District in 1852, corroborates this opinion as to the noxiousness of the drains and the necessity of cleansing them ; he says (Appendix R) " a more frequent and thorough cleansing of them would " be a great improvement, particularly in the hot months, when there is no " flow of water to carry off the offensive matter lodged in them, which here " and there accumulates and stagnates, to the injury of health and to the an- " noyance of the surrounding population."

10. Mr. Kellie writing in 1848, of the populous suburbs of Vepery in- " cluded in the 2d District, speaks as follows, (Appendix N) " The low level of " the ground necessarily renders the drainage very imperfect, and after rain, " almost every compound becomes a stagnant pool, and fluid filth collects in " every street. In this division many of the gutters are paved with brick, but " either from the natural difficulty alluded to, or carelessness on the part of " the inhabitants and Scavengers in allowing the drains to become obstructed, " the dirty water is allowed to collect and stagnate in the gutters, and the " drains seem more a receptacle for the fluid filth of the community, than a " channel for its removal."

" In the very centre of this neighbourhood some of the drains actually " terminate in a large tank, which seems now half full of liquid filth."

" The northern portion of this division is extremely filthy, and no effort, " certainly no efficient one, seems to be made for the removal of the animal " and vegetable remains which every where abound, the smell is most offensive, " and it is difficult to conceive how people can exist in such an atmosphere. " Sickness to a considerable extent prevails in this division and it is in such " localities that cholera usually first appears, and afterwards spreads into the " more respectable portions of the Town."

Among the remedial measures which he proposes, are the adoption of more efficient means of cleansing the streets and drains.

11. Mr. Sanderson speaking of Chintadrepettah a populous suburb in his District, points out the importance of a better supply of water to cleanse the drains. He says, (Appendix R) " But in order that they may be kept

"clean a large supply of water must be used." He expresses the opinion indeed that it will be better to obtain the water by public wells, from which it should be raised, and stored in "large reservoirs in different parts of the "village, communicating with each other, raised above the ordinary level of "the village;" but this part of the subject is out of his province, and he was unaware that his plan of artificially raising the water would involve a cost more than twenty times that of bringing it from a distance by its own gravity.

12. But the fullest report is from Dr. Hunter, Surgeon of Black Town District, which is certainly the part of Madras most urgently in want of sanitary improvement. He first enumerates the nuisances abounding in the Town, comprising the stagnant ditch near the Sailor's Home, dirty tanks, open privies, dung heaps, &c., and declares his belief that they "are the cause of a great deal of sickness." Proceeding then to speak of the drains and sewers, he describes their utility as much lessened by the want of a command of water to wash them out; the present means of cleaning some of them being only an aggravation of the evil. He says, (Appendix P.) "The mode of clearing the "large drains by cooly labour is most barbarous and objectionable, and it has "in more than one instance led to the suffocation of coolies who were employed; "and the throwing of great quantities of black fœted liquid slush on the roads "is highly detrimental to the health of the population, and offensive to persons "passing along the roads. There can be no comparison between the efficiency "of the mode of cleaning drains by constant running water, and by the labour "of Scavengers."

He had before said that dry seasons on the whole are more sickly than wet ones, so that it appears that the universally deleterious influence of wet and damp, are here less pernicious than the accumulation of noisome filth in the uncleaned drains.

13. He then goes on to speak of the sanitary condition of the Town, and declares his undoubting opinion, that to improve "the drainage and sew-"erage of the Town, and supply a current of water through the drains, would "tend most materially to improve its health." He specifies the three localities most in need of being cleansed, and notices that these very localities are the most unhealthy in the Town; and are those "in which cholera generally first "makes its appearance." Some streets which he names, are never, he says, free from fever, and have been repeatedly visited by severe epidemics. He mentions also that an epidemic of very severe intermittent fever had been prevalent in a certain locality during the three months preceding his letter, which he attributed to the "*effluvia from the open drains.*"

Lastly, adverting to the subject of water for drinking and culinary purposes, he says that good water is only to be found in a very few parts of this

extensive Town; and the cost of obtaining daily two chatties (the small quantity set down as required for a family,) being from 4 to 12 annas monthly, according to distance, must injuriously limit its consumption by the poorer classes. Dr. Godfrey also declares his opinion (Appendix O.) that it is "highly "advisable for public health, that water of the best obtainable quality should "be gratuitously and easily accessible in many other localities than those to "which it is at present confined."

14. The Medical Board in forwarding to us the foregoing Reports, confirm with their own opinion all that is said of the necessity for improved draining and cleansing. They write as follows, (Appendix L.) "The com-"plete evidence above adverted to, joined to much of an earlier date and from "other sources, leaves no doubt on the mind of the Medical Board, that the "public health at Madras suffers seriously from a want of perfect sanitary "arrangements; that exhalations from stagnant ditches, open cesspools, and "decaying rubbish, do exist; and that although not positively general, they "are so much so, that nothing but a general system of perfect drainage, "cleansing, and ventilation will be sufficient to obviate the evil consequences "arising therefrom."

"It does not appear to be within the province of the Medical Board to "remark upon the plan proposed by the Chief Engineer for providing such a "current of water as would constantly scour the drains and sewers of all the "districts, whilst at the same time it would furnish an ample supply of the "fluid for domestic purposes, further than to give their opinion, that if the "project is successfully carried out, the advantages would be very great."

15. We have given a lengthened notice to the medical reports, because they have an important bearing on the matter at issue. The other papers need no lengthened notice. Major Lavie states his opinion (Appendix H.) after careful consideration, that the water power which could be obtained from the proposed works at very little extra cost, and with but little waste of water, could be very beneficially made use of at the Gun-powder Works, in substitution for the human and animal labour now employed. He considers that an annual money saving of 7,618 Rupees would thus be effected, and that at the same time a superior gun-powder would be produced. Major Maitland is not of opinion that water power could be advantageously introduced at the Gun Carriage Manufactory.

16. We have also received a second Memorandum on the project from the Chief Engineer, which will be found in Appendix T. In this paper Col. Cotton brings forward arguments against supposed objections to the project, and also enters into some further detail as to the cost and the advantages of the work.

We beg earnestly to commend this paper to the attentive consideration of your Excellency in Council. The Chief Engineer's arguments, (paras 2 to 5) show the urgent necessity that exists for sanitary improvements at Madras, and supported as they are by the practical testimony of the Medical Officers, they appear to us unanswerable; and his demonstration (paras 6 to 10) of the very great benefits to be derived from such a work as that proposed at the Presidency, compared with those from a similar outlay in the interior, and his remarks (paras 11 and 12) on the expediency of looking at all the interests concerned and the objects aimed at, in combination rather than disjointly, and those on the improvement of the Port of Madras, (paras 13 to 16) are no less deserving of attention.

17. We will now add a few general remarks on the project. Its objects are, first, sanitary improvement, secondly, social physical improvement which will be effected at once by the work itself; and thirdly, similar improvement, of which it will be the instrumental means, but less immediately.

1st.—The sanitary improvements are, the providing an abundant supply of wholesome water for drinking and culinary purposes as well as for bathing; the constant cleansing of all the drains and sewers, and the consequent removal of the present causes of disease; and the keeping of the Cooum river always full of sweet water in place of the fetid and offensive mud and muddy water, of which it now consists during a considerable part of the year.

The Medical reports already remarked on, fully prove the urgent necessity for such improvements, for they show that powerful causes of disease and mortality are in daily operation in all the populous quarters of Madras; and that a large proportion of these evils, are directly traceable to the absence of sufficient water. And there appears no reason to doubt that the means now proposed would supply this want; for not only is the plan strongly recommended by four very able and experienced Engineer Officers, viz., by the Chief Engineer and by the Committee nominated in 1851, but further, such examination of the ground as has been made with the levelling instrument, goes to prove fully that the project is not only feasible, but would be singularly easy and cheap. And here we beg particularly to request attention to para 18 of Colonel Cotton's second Memorandum (Appendix T.) where he points out how wonderfully well adapted for the formation of a large reservoir, the proposed site of the new tank is found on examination to be.

18. 2d.—The immediate social gains will be very great.

The greatest no doubt will be the creation of a line of cheap navigation extending through the whole length of Madras, bringing the Cochrane Canal into near connection with many of the most populous localities, and supplying

a cheap, easy and rapid communication extending fifteen miles into the interior, and so operating to cheapen commodities of daily and universal consumption, grain, firewood, straw, &c. A second benefit will be the command of good water at a very cheap rate for watering gardens and plantations, which are now dependent on the bad and costly water of wells.

There will also be a large command of water power for turning mills and for other purposes, which can be let out at a very cheap rate, because it involves very little loss of water; and lastly a very durable material, viz., granite will be supplied for the roads, at a cheaper rate than is paid for the perishable iron stone now used. The granite may be broken near the spot where it is quarried, by means of the water power, and be then conveyed on the Canal to the neighbourhood where it is wanted.

19. 3d.—As more remote benefits derivable from the works now contemplated, we may mention the cheapness with which granite for groins for defending and extending the Beach, will be brought down. And what is more important still, the command of this material in such abundance and at a cheap rate, at once renders the design of a Pier and a ship Breakwater a practicable thing. Of the urgency of such a work we need say nothing, when the whole public of Madras has so lately witnessed the total destruction of four European vessels, and thirteen Native craft, involving an aggregate loss of probably double the whole capital cost of a Breakwater, which would for ever put a stop to such disasters, and prevent the sad loss of life and property, by which, as in the present instance, as also on a similar occasion only a very few months ago they are almost always accompanied.

20. To these advantages which chiefly concern the public at large, we would add another which affects the Government only, and which we are persuaded your Excellency will not think of small importance. Very much difficulty has been encountered, as the Government are well aware, in providing hutting ground for the two Native Regiments which are part of the garrison of Madras. For one of these we are even now in treaty on the part of Government for the purchase of a piece of ground in the heart of Vepery; and we do not anticipate that the land can be obtained, and the buildings and basements constructed, at a smaller outlay than a lack or a lack and a quarter of Rupees: and with all this outlay the situation is not satisfactory, though it is considered by Government to be the best procurable.

The site occupied by the other Regiment at Perambore is by no means good, and the basements formed at a large outlay, are not yet sufficiently consolidated for building on.

21. If the project now under consideration were carried out, it would be

very practicable to have the Troops located at a distance from their duty, and bring in daily by the Canal the numbers required for the guards, by means of a flat and a small Steamer, of which the cost would be trifling. The sites at Vepery and Perambore might then be both abandoned, and the two Regiments might either be cantoned on some of the vacant Government land along the course of the Canal: or, what perhaps would be much better, the Cantonment of Palaveram (constructed 29 years ago at a great expense for the special object of locating the Native Regiments of the garrison, and which, although recently abandoned as too distant a station, is one of the most healthy in the whole Presidency, and has never once been visited by the Cholera), might be again occupied, as the existence of water communication would then render the distance of no importance.

22. We must now briefly consider the financial aspect of the proposed undertaking. As regards the actual cost of the works, there seems very good reason to suppose that all the valuable objects above enumerated, are attainable at an extremely moderate outlay. As yet, in the absence of the necessary detailed investigations, it is only practicable to make a rough and general calculation. But the simple and easy nature of the great bulk of the work, most of it consisting of earth-work and rough stone revetments or plain masonry, renders the computation easy; and Col. Cotton whose long experience in work of the same character qualifies him to make such an estimate with a high degree of correctness, calculates the probable cost at three lacks of Rupees. Further and more accurate enquiry is necessary prior to speaking with confidence on this point; but we do not hesitate to state our decided opinion, that if the cost of the benefits in question should be six lacks instead of three, (which however we see no reason to anticipate,) they would be most cheaply purchased. We may here add that in computing the cost of the proposed works, it must be remembered that the saving of expenditure about to be incurred on objects which would thus be rendered unnecessary, would go far to meet the outlay. Thus, of the 74,000 Rupees sanctioned for the works quoted at the commencement of this letter, a very small part (only a few thousand Rupees) would need to be laid out on those works, as reported to Government in our letter of the 24th February 1853, and the price of the land about to be purchased for locating a Regiment in Vepery (probably not less than 80,000 Rupees exclusive of the buildings required,) would also be saved. These two sums make a lack and a half of Rupees, being a moiety of the supposed cost of the new project.

23. Nor must we omit to point out that the proposed outlay differs entirely from the expenditures just mentioned as sanctioned or about to be incurred, and from all others hitherto incurred by Government for objects connected with the drainage, in that it would not like all those expenditures, be a

mere sinking of capital without return; since the works now proposed would be capable of yielding an ample return, sufficient not simply to pay the interest of the capital invested, but to afford a large profit if it should be deemed expedient to require it.

Besides the direct gain by the use of water power in Government works, there would be three principal sources of income; the water supplied for domestic purposes, which might be paid for by a house water rate, the irrigation, which might pay as at present, by an assessment, and the Canal navigation, which would pay in the form of a toll. Supposing the whole works to cost even five lacks of Rupees, the interest of that sum at 5 per cent. would be 25,000 Rupees a year, and the repairs and superintendence might probably amount to an equal sum; this would give a total yearly charge af 50,000 Rupees. The following scheme shows how that amount might be realized by a very light charge on the benefits conferred by the works.

Saving at the Gun Powder Manufactory by the use of water power.	Rs.	7,600
Irrigation for 3,000 acres of land at 5 Rs. an acre..........................	,,	15,000
House water rate..	,,	17,500
Carriage of 200 tons of goods and passengers 12 miles on the Canal daily for 300 days, at 3 Pice per ton per mile.........	,,	11,250
Total Rs....		51,350

24. Of the land here supposed to be irrigated a part will be rice land; but that will be for the most part, away from the populous localities. The remainder will be gardens and plantations, which will require much less water, but where the quantity taken will be very cheaply purchased at 5 Rs. an acre, as the bad water now raised from Wells costs ten times as much.

The house water rate will of course be on a graduated scale; and the poorest class of houses should be free. There are probably about 140,000 houses in Madras; and of the whole number, about 23,500 bear a rental exceeding twenty Rupees a year, as shewn in the statement in the note.* Sup-

* The following is a classified list of the houses, obtained from the Assessment office :—

Divisions.	Number of Houses valued from Rs.14 to 20.	Number of Houses valued from Rs. 21 to 50.	Number of Houses valued from Rs. 51 to 100.	Number of Houses valued from Rs. 101 to 300.	Number of Houses valued from Rs. 301 to 500.	Number of Houses valued from Rs. 501 to 840.	Number of Houses valued from Rs.841 to 1,260.	Number of Houses valued from Rs.1,261 to 2,520.	Number of Houses valued from Rs.2,521 to 16,00.
1st Division........................	315	2,012	2,006	1,471	146	51	38	22	13
2nd ,, ...	514	2,208	1,927	1,009	49	18	8	7	6
3rd ,, ...	1,125	1,201	242	127	24	26	4	2	0
4th ,, ...	1,328	2,215	847	331	101	104	53	43	11
5th ,, ...	2,445	4,505	1,706	664	76	72	49	77	34
Total....	5,727	12,141	6,728	3,602	396	271	152	151	64

N. B. —Houses valued at *less than* 14 *Rupees per annum*, are not entered in this Statement. Such Houses or huts consist of one or at the most two rooms.

Assessor's Office, Madras, 30*th September* 1852.

posing all houses of a lower rent to be exempted from the rate, the following scale shows how lightly the payment would fall : we do not propose this as a scheme for actual use as the gradation of charge ought to be more numerous and more accurate, but it is sufficient to show how trifling the demand would be on each house.

4000 houses	at	4	Annas	a year	Rs. 1,000
4000 "	"	6	"	"	" 1,500
4000 "	"	8	"	"	" 2,000
4000 "	"	12	"	"	" 3,000
3000 "	"	1	Rupee	"	" 3,000
3000 "	"	1¼	"	"	" 3,750
396 "	"	2	"	"	" 792
271 "	"	5	"	"	" 1,355
152 "	"	8	"	"	" 1,216
215 "	"	12	"	"	" 2,580
				Total Rs....	20,193

Thus at these very moderate rates on a limited proportion of the houses, a much larger sum is afforded than is supposed to be required.

Houses now pay a rate of 5 per cent. on the rental to the Assessment fund for the maintenance of the roads and other municipal purposes amounting in the aggregate to Rupees 1,28,610 a year. A very great saving will be affected in that item through the substitution of granite for iron stone, at a rate certainly as low as is now paid for the latter ; so that probably this saving might cover the payment for the water.

25. As regards the tolls : Colonel Cotton gives in his second Memorandum (para 21) a table of the traffic along the road leading out of Madras by Palaveram, in a single day. The passenger conveyances were 68, and the goods-bandies 1,534 ; and supposing only two thirds of the latter numbert o be loaded, the quantity of goods carried will be about 500 tons. The number of foot travellers was nearly 3,000. The proposed works would supply water carriage for 20 miles in precisely the same direction, at an extremely cheap rate ; and besides the traffic above stated there will be all that between Black Town and the other parts of Madras, which is very great ; and it therefore appears only a very moderate estimate, to expect that 300 tons will be carried daily on the Canal for an average distance of 12 miles.

Among the items of gain to Government by these works, must be mentioned the saving in the repair of all the Government roads (as per margin) 20 miles in length, on which the average annual outlay has been not less than

The average cost per mile per annum of the Government Roads about Madras during the last 10 *years, has been as follows :*

1ST CLASS ROADS.

NAMES OF ROADS.	Average cost per mile in each year.
	Rupees.
1. Canal Basin Road	771½
2. Hospital Road	1,192
3. Portion of the Mount Road between Govt. Bridge and Wallajah Bridge	912
4. Bambfield Road	814
5. Canal Road	778
6. Elephant Gate Road	683½
7. Band Practice Ground	667
8. Thumboo Chetty Road	789½
General average of all....	817
2ND CLASS ROADS.	
9. Anderson's Esplanade Road	550
10. Body Guard Road	640
11. Burial Ground Road	506
12. China Bazaar Road	567
13. Hospital Gate Road	467
14. North Beach Road	671
15. Royapooram Esplanade Road	527
16. Thieving Bazaar Road	655
General average of all....	574
3RD CLASS ROADS.	
17. Basin Bridge Road	312
18. Northern Road	312
19. Cochrane Basin Road	423
20. Hall Tank Road	394
21. Monegar Choultry Road	370
22. Clive's Battery Road	298
23. Govindapah Naick Road	278
24. Mount Gate Road	243
25. Island Road	184
26. Salt Cotaur Road	182
27. Expense Magazine Road	176
28. Codambaucum Road	152
General average of all....	270

410 Rupees per mile that is, the whole outlay during the last 10 years Rs. 90,060-13-1—being Rupees 9,000 a year. And further a saving will be effected on all the roads under the Assessment in length about 120 miles — specially the Mount Road, partly through a large part of the heavy traffic being diverted to the Canal, and partly from the increased cheapness and durability of the material. We have not however included either of these items in our estimate of the returns.

26. Such then is the project which we have the honor to submit for the consideration of Government. The interests with which it deals are of no ordinary magnitude, being the health, physical comfort and well being, and social improvement, of about 700,000 human beings. We entreat your Excellency to consider the real bearing of the proposal in this regard. There are very few places in the world in which so large a number of persons are brought into such close contact as in Madras. A population of above 700,000 souls is located within an area seven miles long, by, on an average, not more than two and a half broad; and though it is true that this tract contains extensive open spaces, yet on the other hand, in the populous parts of it, Vepery and Choolay, Chintadrepettah, St. Thomé, Triplicane, and above all Black Town, the population is packed as close together as it well could be, where most of the houses are of one story only. Even in thickly peopled England there is no place, except London, with so large a population in proportion to the extent, and only three exceeding a moiety of this proportion. In the

whole of Europe there are only two more cities of so dense a population, viz., Paris and perhaps Constantinople. In Asia, if we except some few of the China and Japan cities, there are none approaching to Madras in population, Calcutta has less than one half, and if we look to the western world, we find few among all its seats of active industry, with a population reaching one half of that of Madras in proportion to its extent.

27. Thus it appears that there are on the whole surface of the Globe, but few spots where so large a mass of human beings are congregated in so small a space ; and if it be answered, that other cities much less populous are more wealthy, we admit the fact, but we would ask in reply whether that can fairly be made a plea for refusing help, or whether rather it is not an additional reason for giving such aid, since those who are so poor can do the less for themselves. Let it be remembered that the object in view is not to adorn or beautify the city, nor even to minister to the amusement or recreation of the inhabitants; on both which objects however, vast sums have been expended by less wealthy Governments. It is nothing less than to provide a dense, poor, and ignorant population with an adequate supply of the first necessary of healthy existence, and thus deliver them from a large amount of actual suffering and prolong their lives. And what after all, is it that we ask for the noble object of delivering from the dominion of disease and death this destitute population of 700,000 persons, and at the same time giving them the means of gaining increased wealth and increased comfort ? Only the outlay of twenty, thirty, or say even one hundred thousand pounds sterling. And even this is not asked as a gift, but rather as a loan or an advance, since the works themselves will abundantly repay the outlay. In our own country and in America, hundreds of thousands of pounds have repeatedly been spent on the mere object of providing good water for a population equal to only a fifth or a tenth of ours ; and a project has recently been laid before the authorities of Bengal for supplying water to Calcutta (a population of only 230,000 persons, being ⅓d of that of Madras) at an outlay of 67 lacks of Rupees, with an annual expenditure of 5½ lacks for working expenses.* But here, such are the natural advantages existing, that a population of 700,000 persons can be supplied, not simply with water for drinking and sewerage, but with the means of irrigation and water carriage, probably for three lacks (£30,000) and almost certainly for not more than 6 lacks (£60,000.) It is true that this scheme does not contemplate the laying on of water to each house ; that is a luxury for which we must be content to wait sometime longer : but it will at least place an abundance of good water within easy reach of every part of the whole inhabited tract, and will remove active causes of disease now everywhere abounding.

* See Selection from the records of Bengal Government, No. 10, page 14.

28. Looking at all the circumstances, we think we may confidently assert that no project laid before any Government in any part of the world, ever promised such vast and various benefits to so large a number of persons, at so small a cost. And being ourselves thus deeply impressed with the great importance of the project, we are anxious to bespeak for it the full consideration of Government. What is now wanted is a more minute enquiry with the view of accurately determining how the project may best be carried out in its details, and what will be its exact cost. For this purpose we beg strongly to support the proposition of the Chief Engineer, that an Engineer Officer of experience, with a suitable establishment, be nominated without delay to the special duty of investigating and reporting on the project. We are aware that there are few Officers of Engineers available for any extra duty; but for an object of this great importance it appears to us that an Officer might be even withdrawn from other employment, and if it should please Government to call upon us, we shall be prepared to name an Officer who, we think, could be spared, and who is in every way competent to the task. We beg further to recommend, that Government will be pleased at the same time to place at our disposal a small sum, say 2,000 Rupees for contingent expenses in connection with the enquiry; viz., making experiments as to soils and materials, and in other ways, with a view to the more accurate determination of the probable cost of the works.

We have the honor to be,
Right Honorable Sir,
Your most obedient humble Servants,

G. CONRAN, Brigadier,
Commandant of Artillery.

W. COTTON, Lieut-Col.,
Chief Engineer.

G. BALFOUR, Major,
Stipendiary Member.

MILITARY BOARD OFFICE:
Fort Saint George,
26*th* *April* 1853.

APPENDIX A.

MEMORANDUM BY LIEUT.-COLONEL A. T. COTTON, CHIEF ENGINEER AND MEMBER, MILITARY BOARD, ON THE REBUILDING OF THE NORTHERN TUNNEL, &c.

The circumstance was pointed out to me by the Secretary, that no provision has been made for the discharge of the contents of the sewer during the alteration of the Tunnel, which it is calculated will take 18 months, either an open ditch might be cut parallel to the Tunnel with some temporary work to protect the mouth and so discharge into the Sea, or it might be discharged into the Cooum; but both of them appear to me so very objectionable on account of the pollution of the air around the Fort, that they would cause, that I consider, that the alteration of the Tunnel on the plan sanctioned cannot be carried into effect without this difficulty is met in some other way. Again, in the Report of the Committee ordered by the Court to report upon Captain Boulderson's plan for washing out the Black Town drains, it is recommended, that the only alteration that should be made to the Tunnel, is, that the floor should be so raised from its inside ends as to reverse the slope and give it the same inclination to seaward as it now has to landward; if this only were done it would meet the present difficulty, because the mere raising of the floor would be a work of so small extent, that it could with good arrangements be done in a very short time, and consequently the stoppage of the escape of the sewage by this Tunnel would not be of so much consequence.

The Committee's Report however seems to put the whole matter in an entirely new point of view. The proper management of the sewerage of Towns has been made the object of so much thought and attention within the last very few years, and so much new light has been thereby thrown on the subject, that it seems extremely advisable, that the whole question of cleansing and watering Black Town [and the rest of Madras of which Black Town forms only a small part,] should be re-considered with the help of the valuable works written on this subject that are now accessible. It seems quite evident, that the question has hitherto been considered wholly by those who have had no experience in such works in England, nor have had much opportunity of making themselves acquainted with what has been done there, and the results; I

therefore entirely concur with the Committee in their recommendation, that an Officer should be expressly appointed to investigate the matter in a complete manner. I feel confident that one great reason, [though much has certainly been effected,] why the end has been so far from having been fully attained, is, that much more time and attention was required than was supposed necessary, consequently that it was left in the hands of those who had a vast pressure of other business upon their hands, and therefore could not take a view of the whole matter in all its extent. It seems to me an entire mistake to take up the cleansing of Black Town separately from watering it, the two being so evidently closely connected, so that if the latter is attended to, the former will be greatly improved by that alone. Further, at this moment, the subject of the improvement of the Cooum is now before the Board and my opinion is called for, and I consider this also closely connected with the watering of Black Town, inasmuch as that the works necessary for the former would go far towards effecting the latter also, for to correct the Cooum I consider that a supply of water must be obtained, and if water is brought to the Cooum, it may at the same time be carried into Black Town.

An Officer has thus been set apart for the thorough examination of the subject of rail roads, doubtless an essential arrangement, which was decided upon after several years of partial enquiry, which only shewed, that the whole time and attention of an Officer were required.

Nothing can be more evident to me, than that there is ample, and more than ample room for the employment of an Officer on this subject and those connected with it. I think it quite impossible for any Officer to do what is required in this way, if he has the ordinary duties of an office to carry on at the same time.

The particular points at this moment under consideration are,

The alteration of the Tunnel and Drain for which together, 73,000 Rupees have been sanctioned.

The general subject of the cleansing of Black Town.

The improvement of the Cooum.

The survey of all the lands of Madras in detail, and with those are intimately connected—

The watering of Black Town.

The cleansing and watering of all the rest of Madras.

The connection of the Northern Canal with the Cooum and extension of its navigation into the heart of Madras—for the improvement of this work 70,000 Rupees has now been sanctioned and its revenue of 30,000 Rupees a

year would certainly be very greatly increased, if the goods brought by it could be delivered in the heart of Madras.

And lastly the land communication of Madras, for if water carriage is extended within Madras, the saving of expenditure in wear of roads would be a considerable sum.

The cleansing and watering of Madras for sanitary purposes may be considered as a work of necessity, and the irrigation, diminution of land carriage and connection of the heart of Madras with the Northern Canal will certainly yield a large revenue; there can be no question that water for irrigation will be far more valuable close to Madras than in the interior, and it is equally certain, that the hard brackish water now drawn from thousands of wells at a cost of about 1 Rupee for 300 cubic yards, would be gladly exchanged for soft water at $\frac{1}{2}$ or $\frac{1}{4}$ of that cost, a rate which would yield a large profit to Government.

To assist in shewing the practicability of a scheme that would effect or promote all the objects above enumerated (except the survey) I would sketch out a plan suggested by the proposition contained in the Committee's Report, viz., that fresh water should be obtained for Black Town by means of water stored from the Adyar or the Cooum.

I would then propose, that a Tank should be made by damming up the Adyar near the Mount, where there is an extensive plain almost unoccupied, and on a level that would command all Madras; it should contain from 20 to 50 Millions of cubic yards of water, and be of such a depth as to ensure a full supply for *drinking* purposes through the second dry season; from thence the water should be led, a small part down the Adyar to improve the state of that River, and the principal part by a Channel into the long Tank, thence into the Nungumbaukum Tank, and then by a cut into the Cooum, a portion for the supply of Black Town being carried by the line of the Spur Tank and across the Black Town Esplanade to the centre of Black Town, being carried across the hollows in pipes so as to be delivered at the level required, the whole of this line of water from the Mount to the Cooum and by the Black Town ditch, and a new Channel along the North face of Black Town, to the Beach near Clive's Battery, should be made navigable, the total fall of about 40 feet being provided for by about 6 locks.

The cost of this would be about—

Tank to hold 30 Millions cubic yards...	1	Lac.
Six locks at 12,000 Rupees...............	$\frac{3}{4}$	”
Annicuts across the Cooum...............	$\frac{1}{4}$	”
New cuts cleaning Black Town ditch, &c.	$\frac{1}{2}$	”
Water pipes and sundries.................	$\frac{1}{2}$	”
	3 Lacs.	

The objects obtained by these works would be—

1st.—The first and fundamental point would be gained of an ample supply of fresh water for drinking and carrying off filth not only for Black Town, but for all Madras.

2d.—This water being conveyed by pipes into the heart of Black Town at a commanding level, would be freely used by the inhabitants, and hence at once a great effect would be obtained in keeping up a much larger supply of fluid in the present Drains.

3d.—From the long Tank, &c., it would find its way by the various irrigating and other Channels, into all the other Towns situated within the limits of Madras, tending in a vast degree to purify them.

4th.—Both the Adyar and Cooum would be kept supplied with fresh water during the whole year.

5th.—All the cultivated lands and compounds of Madras could be supplied with water to a certain extent.

6th.—A line of navigation through the heart of Madras and connecting the Mount, North Beach and Northern Canal would be obtained, by which the roads would be greatly cleared and a large sum in road repairs saved; for instance, firewood brought by the Northern Canal would be landed at various points very near where it was required, the same with bricks manufactured near the long Tank, &c.

7th.—Stone from the Mount could be brought to the Beach south of the Fort and to that north of Black Town and with very little land carriage to all points intermediate or beyond, reducing the price of that material to $\frac{1}{4}$ of its present cost, a matter of incalculable importance with reference to the defence of the Coast and improvement of the Port.

There would thus be a sound and extensive basis for improvements of almost all kinds in Madras. The sanitary state would by this alone be immensely improved, and upon this foundation whatever erections might by degrees be seen to be advisable might be carried on. Thus the reformation of the Black Town Drains either by merely correcting the levels, or by altering their construction, might be carried on to any extent; the detailed distribution of the water by pipes through the Black Town, the details of draining and watering the other Towns of Madras, the extension of the Tank so as abundantly to irrigate the whole of the lands, the extension of the navigation so as to still further diminish the cost of the roads, the connection of the Cooum or the Tank with the line of the Canal to southward so long contemplated

when it is executed, the free use of granite for various purposes, especially the roads and above all, for the Port; all these improvements might be carried on under the greatest advantages.

I merely sketch out this scheme to show that the basis of vast improvements is within our reach, and that we should at once, whether works were carried further or not, have an immediate and vast advantage. It is quite evident that one of the great mistakes under which these questions have been hitherto carried on was, the supposition, that water was much more expensive than it really is. In the Carnatic generally we can preserve water by catching it in Tanks at 1,000 cubic yards per annum, for every Rupee of Capital expended or taking the interest of capital at 5 per cent, the price is 10 Pice per 1,000 cubic yards. To raise this quantity of water by Bullock labor 12 feet costs about 3 Rupees or 60 times as much, and by steam power the same height would take about $\frac{3}{4}$ Rupee or 15 times as much; so that were it determined to wash out Black Town with Sea water, it would still be advisable to bring in fresh water as a motive power to raise it in preference to steam. A 6 horse Engine would cost 3,000 Rupees when put up, and to work it for 16 hours a day, would cost 4,000 Rupees a year, the interest of 80,000 Rupees equal with the cost of the Engine itself to a capital of 83,000 Rupees for raising 10,000 yards a day or $3\frac{1}{2}$ Millions per annum, while the same power might be obtained by a water wheel worked by water stored in a Tank and brought to the spot for a much less sum.

The sanitary effects of such a scheme would of course be beyond calculation of money, but there would also be obviously large direct returns in money. If only 10 Millions cubic yards were used for irrigation and sold at 1 Rupee per 1,000 cubic yards, $\frac{1}{3}$d of what water much inferior for irrigation raised from the hundreds of wells in Madras now costs, it would fetch 10,000 Rupees a year the Interest of 2 Lacs; several thousand Rupees a year would be saved in the carriage of stone for groins, &c., if only the same quantity continues to be used as hitherto; a large sum would be saved in the road repairs, and if necessary, a toll might be levied on the navigation; these are besides the great profit to the public by cheap water and cheap carriage.

I trust it is thus shewn that—

1st.—The various improvements now required in Madras are so intimately connected, that it is entirely a mistake to plan one without considering the whole.

2d.—That it is a mistake to lay out so large a sum of money (73,000 Rupees is now sanctioned) in any works which are not fundamental unless it is quite clear that they will form a necessary part of what is ultimately to be done.

We *must* pause to consider, what is to be done about the alteration of the Tunnel, as the estimate does not provide for the escape of the sewerage for 18 months, the time which the proposed contractor requires to execute the work, and a Committee assembled by order of the Honorable Court conclude, that the whole question absolutely requires an Officer of experience to be set apart for it, and I am therefore of opinion, that this is the proper time to examine the matter in its full extent. Instead of sending an experienced Engineer to any place where there is no prospect of any work of importance being carried on, and where the duties can be properly performed by an Officer without scientific acquirements, I would undoubtedly rather appoint one to such a matter as this, where professional talents and experience would be so well employed.

With respect to the question of what is to be done respecting the alteration of the Tunnel my suggestion is, that the Committee's proposition should be carried out, viz., that the slope of the flour of the Tunnel should be so altered so that the water cannot lodge in the inner end. This would be so trifling a work, that it could be done in a short time, and the escape of the sewerage stopped only for a very few days if at all, as perhaps one vent of the Tunnel could be altered at a time, the cost of this would be only about 1,500 Rupees. But in connection with this, I would strongly recommend, that the Committee's suggestion of placing a small Steam Engine to raise the sewerage at the head of the Tunnel should be carried out at once. This is one of those things which have been lately brought forward at home and which is so obvious when once pointed out, viz., that a very small power of Engine applied to this purpose, that is, to raise the fluid a few feet, from the lower end of a main sewer, so as to enable it to flow off to some outlet, when otherwise it would have lodged and stagnated in the sewer, will do more to keep the sewer clear and prevent fermentation than ten times the power applied to raise a considerable body of water a great height, in order to introduce it at the upper level of the sewers and so wash them out. If a very small Engine, (2 horse power,) were placed at the inner end of the Tunnel to raise the water as it flows from the main sewer and discharges it into the Tunnel, there would be no accumulation at all in the main sewer, no time for fermentation and no checking of the current down it, such an Engine there is now, unused, at Dowlaiswarum, it could be taken for this purpose at 1,000 Rupees, and another 1,000 would do all that was required to set it at work. It would take about 4 Rupees of coal a day, and 2 Rupees for attendance, &c., to work it, supposing it were worked the whole 24 hours which probably would not be necessary. In connection with this I should mention that I consider it a strange oversight that the cistern at the inner end of the Tunnel should have been left open. There can be no doubt, that the effluvia that are spoken of, as proceeding from the ditch between the Cooum and the Tunnel mainly come from this cistern; any person may satisfy himself

of this by going to the spot. There cannot I conceive be a question, but that this trifling work should be done immediately. The fluid raised by the Engine would be drawn and discharged through pipes, so that there would be no communication whatever between the sewerage and the open air.

With respect to the open ditch as I have said above, the principal part of what has been charged to it belongs to the cistern. I think it will be sufficient to raise the end near the cistern with earth and slope it off towards the Cooum, leaving however still a hollow, so that in the heavy falls of rain a portion of the water may flow off that way as at present, if the Tunnel should be insufficient to carry it off. I think this will be found almost if not quite to remove the evil. I would not if possible spend any large sum of money now, and I feel confident that the entire filling up of the ditch is unnecessary.

What I would therefore propose should be done at present is—

1st.—The covering of the cistern, which will certainly remove an intolerable nuisance at a trifling cost, about 100 Rupees.

2d.—Raising the floor of the inner end of the Tunnel about 1 foot 4 inches, and sloping it to the present level of the mouth, about 1,500 Rupees.

3d.—Filling up partially the end of the open ditch next the Tunnel, about 1,000 Rupees.

4th.—Putting up a small Engine to raise the sewerage into the Tunnel and prevent its stagnating in the main sewer, about 2,000 Rupees.

These things seem to me simple and obvious, and they will cost little—about 5,000 Rupees.

And for the proper investigation of the various matters now under consideration and enumerated above, I would beg most strongly to recommend, that as recommended by the Committee, an Officer of talent and experience should be appointed to take a view of the whole matter at once, and digest a plan by which the various objects may be attained, being convinced that it is impossible to settle one of these points effectually and economically without considering the others. The trifling works above proposed cannot of course in the least tend to render the extensive works the less necessary.

I conclude with two observations—

1st.—As it is necessary that this paper should be short, I do not attempt to answer the various difficulties that may of course appear in this case, especially to non-professional readers; but I feel confident, that there are none that cannot be easily met, and I shall be ready to answer any question that it may seem necessary to put.

2d.—There are many important objects besides these now spoken of, that might be attained by such a project as that sketched out, some which have occurred to me, such as the breaking up granite for roads by water power and conveying it by the navigation, &c., and no doubt many others that will not be thought of till fresh water is flowing through Madras; in fact I am convinced, that the improvements in this City that would follow upon an abundant supply of fresh water brought into Madras at so cheap a rate as it can be obtained, are incalculable.

(Signed) A. T. COTTON, Lieut.-Colonel,

Chief Engineer.

CHIEF ENGINEER'S OFFICE:
Fort Saint George,
31*st* *August*, 1852.

APPENDIX B.

FROM THE MILITARY BOARD, TO THE SECRETARY TO THE MEDICAL BOARD.

SIR,—The Military Board, having at present under consideration, an important project, involving great improvements in the drainage and cleansing of the town of Madras; I have the honor to request, you will bring this question before the Medical Board, as this Board will be glad to be assisted by the advice and suggestions of your Board, on a question connected with the sanitary condition of the numerous population of Madras.

2. The Military Board are aware that the absence of any registration of Births and Deaths, prevents that accurate statistical data being collected, to prove the existence of causes destructive to health; but from the extensive information possessed by your Board, they will probably be enabled to state, whether injury to the public health is now occasioned, by causes capable of removal; whether exhalations from stagnant ditches, open cesspools, decaying refuse do now exist; whether injurious to health, and if so, whether they are general or confined to particular localities, and if so, to what districts of the town; whether they extend their influence to several districts, or are restricted in their effects, and at what seasons of the year, or state of the atmosphere, more or less hurtful.

3. The Medical Board are aware that, the sewerage of Madras is carried on by means of open drains connected with covered main sluices, discharging themselves into the Sea; but that all being nearly on a dead level, the aid

of Scavengers is extensively required for the streets and open drains, but that the main drains have always been defective in their operation.

4. The project under consideration is to provide such a head of water, as to secure a current of water through the drains and sewers of all the districts, sufficient to keep them constantly clean and sweet; and taking for granted the feasibility of securing such a quantity of water as will attain this object, the important question now submitted for the consideration of the Medical Board is, whether more effectual cleansing is really needed, and whether scouring or flushing, by water, would accomplish this more efficiently than by means of Scavengers; and it would be of great value, if the Board could state any facts to prove the necessity for greater cleanliness, and whether, after a long continuance of dry weather, the offensive exhalations increase, and consequent thereon, disease; and whether the facts that, after a fall of rain, the Sea along the beach is more than usually saturated with filth, discharged from the sewers of the town, does not prove the necessity for more constant scouring; so as, if possible, to carry off all refuse quickly and before entire fermentation has commenced. The cost at which this project can be carried out is an important point for consideration, and as the works, for the water, for the sewerage can be added to without any great outlay, in proportion to the additional store of water to be secured, it would be economical to make the works useful for other purposes than the mere cleansing of Madras: probably the attention of your Board may have been given to the sufficiency or insufficiency of water for domestic uses, and they may be enabled to state, whether water is in general deficient, or only in particular localities deficient; and whether if an ample supply of good water, in far greater quantity than hitherto, were supplied, unhealthiness and inconvenience would be alleviated.

5. This Board would be obliged by being furnished with an estimate of the quantity of water consumed by the people in different parts of Madras, stating its quality, from what source obtained, and from what distance from the houses.

This information would be useful as a guide for estimating the quantity of water required in different districts for domestic purposes, by comparing it with the quantity used at Home, generally estimated at from 40 to 65 gallons per house, or say 13 gallons per individual per diem, equal to about 2 cubic feet of water, or probably the number of chatties of water for each house, per diem, would be an approximation.

6. Although water is not bought in this country as at Home; yet it is often paid for by labour, which is money to the poor; and supposing each household to require 50 chatties of water daily, or about the Home consump-

tion, then the distance travelled over to bring in this quantity from the well, or source of supply, to the house, will be the measure of the cost of the present supply of water, by valuing the time taken up in carrying the water at the rate of daily hire given to a cooly for a journey of 10 miles; and considering that good water could be supplied from the works intended for sewerage, at from 2 to 4 Annas per annum per house of 5 persons, in quantity equal to the English consumption, the present question is well deserving attention, both for the benefit of the people and as diminishing the cost of water for sewerage and cleansing purposes.

I have the honor to be, Sir,

Your obedient Servant,

(Signed) A. H. HOPE,

20*th October* 1852. *Acting Secretary.*

APPENDIX C.

To E. F. ELLIOT, Esq.,

Chief Magistrate and Superintendent of Police.

Sir,—The Board being desirous of availing themselves of the intimate knowledge you possess of the various localities of Madras, desire me to solicit your observations on the project set forth in the enclosed Memorandum of the Chief Engineer, for constructing in the vicinity of Palaveram a great work, for the purpose of collecting such a head of water as will allow of a constant and effectual flushing or scouring of the drains and sewers of Madras, and for all other purposes to which water can be applied, such as Irrigation, Water Power, Baths, &c. Before carrying out such a work, it is essential to ascertain, whether injurious effects are at present produced from the exhalations from the sewers and drains;—whether in your opinion more efficient measures are required to ensure the removal of filth and effluvia;—whether the existing drains and sewers are properly constructed, so as to ensure the cleansing by Scavengers being sufficient to remove all those causes likely to produce disease or prove injurious to health;—and if not, whether the use of water would render alterations less necessary;—whether in general Cholera, Fevers, and other diseases exists throughout all Madras, or are more prevalent in particular localities and particular seasons, and if so, to what causes attributable; and if existing, whether cleansing by water would diminish sickness, and to what extent.

You are aware that the expenses from the Assessment funds for cleansing and other purposes are very considerable, as follows :—

	Cleansing Roads and Drains.			Reform and Repair of Roads.			Repairing of Drains.		
	Rs.	A.	P.	Rs.	A.	A.	Rs.	A.	P.
1st Quarter ending 31st March 1851..........	9,063	9	5	7,118	9	10	3,577	4	9
2nd „ „ 30th June „	9,451	2	0	5,281	13	5	7,373	15	1
3rd „ „ 30th Sept. „	9,466	9	2	5,087	14	2	7,236	14	11
4th „ „ 31st Dec. „	9,049	15	8	6,258	10	8	3,231	11	1
Total....	37,031	4	3	23,747*	0	1	21,419*	13	10

And as the project contemplates the application of water to scour or flush the drains and sewers, the question is, whether this will in your opinion, more effectually and certainly remove the refuse from every corner of Madras, than is at present done by the Scavengers; and further, whether it could be done more cheaply; if so, what amount might probably be saved. In England it is calculated that 1,000 yards form the amount which can be effectually swept by a Scavenger in one day, and taking 8 yards as the average width of the streets, this will be 8,000 superficial yards for each Scavenger.

The Board are inclined to consider that the filth is not at present effectually removed, because offensive emanations increase after a long continuance of dry weather, whilst after a heavy fall of rain, the Sea along the Beach is completely saturated with filth of the most offensive description; and seeing the good effects of a fall of rain, the Board cannot but think that a command of water, allowing of its being generally directed for the purpose of cleansing, must be more efficient than the present mode of scavengering; but the adoption of the measure will depend mainly on the question, whether by its use any reduction might be made in the expense at present incurred for scavengering.

Her Majesty's Justices have to make a continuation of the main drain undertaken by Government for the sanitary improvement of Madras, involving also the construction of numerous small drains in order to complete the works; and the Board wish to know what diminution of outlay to the Assessment funds you think would result from the general use of water, by obviating the necessity of arranging the works for facility of scavengering and for receiving the surface rain water.

This project contemplates collecting a very large head of water, and as the additional works for securing a still larger store of water would be but trifling;

* It would also be useful to ascertain the portions of the expenditure for new works, separately from that for repairs and reforms to roads and drains, in order to ascertain the value of water in its application by preventing the necessity of altering defective constructions.

and as it is the Board's duty to endeavour to make the work as economical as possible, by rendering the water available, if possible, for other purposes, in order thus to lessen the expense and diminish the cost of the water to be used specifically for cleansing the Town, I am desired to solicit suggestions as to the other uses to which an abundance of water could be beneficially and profitably applied.

The Board are inclined to doubt whether the present supply of water for household purposes be sufficient; or if sufficient, whether it is conveniently accessible; and they would desire to be favored with your views as to whether more water would be used, and with advantage to the health and comfort of the people, if an abundant supply were cheaply and easily procurable.

The consumption of water in England is reckoned at from 40 to 65 gallons per family, or say 13* gallons per individual per diem, equal to 2 cubic feet or nearly $\frac{1}{13}$ of a cubic yard of water, and calculating the same quantity of water for each person in Madras, then 700,000 Inhabitants $\times$ $\frac{1}{13}$ cubic yard=54,000 cubic yards $\times$ 365 days=19,440,000 cubic yards of water†; but probably a greater proportion would be used in so hot and dry a climate, if it were more abundant. You may perhaps be able to furnish the Board with a rough estimate of the quantity of water now used in particular districts of Madras. And supposing the present supply to be insufficient, the Board wish to have your opinion as to whether some payment in the shape of a House Tax or Water Rate might not be levied in return for an abundant [supply of good water.

Supposing each household of 5 persons to consume daily 10 cubic feet of water or 65 gallons, (equal to about 25 or 30 chatties of water each containing 32 lbs.) then the annual consumption for each household would amount to 130 cubic yards, and this quantity could be delivered near to Madras at the main Canal at a charge of only about 6 Pice per annum, allowing only 5 per cent. per annum on the Capital expended. In addition thereto, a rate must be levied to cover the outlay for the subsidiary works to convey the water to, or close to each house; but calculating 140,000 houses, then a charge of 1 Anna per house would give 9,000 Rupees per annum, which is equal to the Interest at 5 per cent. of a Capital of 180,000 Rupees. But as the main duct can be brought in on a high level, the use of earthern ware pipes will probably be found quite sufficient for the distribution of the water to the separate houses so as to make that outlay cover all expenses.

* Equal to about 5 or 6 chatties each of 32 lbs. weight of water per chatty.

† The cost of the works for the supply of water for household use in Madras, say 20 Millions of cubic yards would be 3 Lakhs of Rupees, the Interest of which at 5 per cent. is 15,000 Rupees per annum, securing a supply of 1,333 cubic yards or 233,275 gallons for 1 Rupee, or about 15,000 gallons for 1 Anna, or for a household of 5 persons each consuming 12 gallons per diem is, 21,900 gallons per annum, the cost would be 1½ Anna.

Although the water at present used may not be bought by the people, you may perhaps be able to favor the Board with some idea of the quantity of labor required to supply a house with the water for domestic purposes, and by estimating the distance travelled between the houses and wells, and the time employed valued at the rate of a cooly's daily hire for each 12 miles, the cost of water may thus be calculated, and trifling as the cost of the chatties and other vessels for holding the water and drawing it from wells may be, yet even in this respect some expense may be saved to the poorer classes by the facility of supply.

The establishment of public baths and wash-houses presents itself as one of the first objects for which an abundant supply of water could be made available, and doubtless with suitable arrangements to prevent the prejudices of caste interfering, the people would be induced to make use of them ; and calculating 9 cubic feet of water per diem ; for each bath, only 120 cubic yards will be required annually for each bath ; and this quantity could, as above stated, be delivered in Madras at a cost of about 6 Pice.

It is also worth consideration, whether supplies of water for extinguishing fires and watering the roads and streets, could be provided with any probability of reimbursement; and the Board think that this would be the case at least as regards the roads, since the constant watering must tend to diminish the abrasion, and thus lessen the necessity for and cost of repairs; and in making and repairing roads an abundance of water might be found an economical application for binding the materials. Calculating the quantity for watering the roads at 3 gallons per superficial yard per diem, then for 1 mile with a width of 8 yards there would be required 260 cubic yards of water per diem, and annually for each mile of road of say 8 yards wide, 100,000 cubic yards; which could be supplied (as above) at a cost of 60 Rupees per annum, or for the estimated extent of road of 100 miles, total 6,000 Rupees per annum.

The present cost of hard water for gardens, drawn from wells by the most efficient power now existing, is about 1 Rupee for 300 cubic yards, or say 3 Rupees for 1,000 cubic yards, and even calculating the immediate outlay for the works of the reservoirs at 3 Rupees for every 1,000 cubic yards of water stored up, instead of the actual rate of 1 Rupee per 1,000 cubic yards, then the probable cost of Tank water at 5 per cent. per annum, on this 3 Rupees Capital is, about 30 Pie for 1,000 cubic yards, which will give 6,000 cubic yards of water for 180 Pie, or nearly 1 Rupee, equal to only about $\frac{1}{20}$ of the present cost of water drawn for gardens, with the additional advantage of soft water; and taking into consideration all these circumstances, are you of opinion that any considerable demands for water for garden and other cultivation would be created, and if so, to what extent, and what rate would induce such a demand?

Our position in this country affords many facilities which we have not at Home for the execution of works for the supply of water, there being no vested rights of such a nature as to interfere with the plans of Government; and the habits and character of the people, and the manner in which they are amenable to regulation, would render less costly works sufficient for the purpose, thus ensuring supplies of water at a charge considerably less than in England.

I have the honor to be, Sir,
Your obedient Servant,
(Signed) A. H. HOPE,
Acting Secretary.

8*th November* 1852.

APPENDIX D.

TO THE SECRETARY MEDICAL BOARD.

Sir,—With reference to my letter, number and date as per margin, I have the honor to enclose copy of a communication forwarded to the Chief Magistrate with the Military Board's request, that you will submit it to the Medical Board as it contains some additional points connected with the supply of water, on which the observations of your Board would be of advantage.

6475, dated 26th October 1852.

I have the honor to be, Sir,
Your obedient Servant,
(Signed) A. H. HOPE,
Acting Secretary.

8*th November* 1852.

APPENDIX E.

TO THE SUPERINTENDENT OF GUN POWDER MANUFACTORY.

Sir,—The Board having under consideration a project for forming a reservoir of water in the vicinity of Palaveram, which will give a command of Water Power for Madras; I am desired by the Board to request you will state what extent of power you could employ in the Manufactory, and to what extent you will diminish the animal and human labor, and the value thereof per annum.

The object of the Board is to ascertain from all the Public Establishments, the purposes to which Water Power could be applied; and in order to enable you to appreciate the importance of the question, I am desired to point out that if it could be so arranged that Water Power to the extent of 500 Powers of Bullocks were used at Madras, it would be worth 60,000 Rupees a year, the Interest upon 12 Lakhs; and this extent of power would only require 50 Millions of cubic yards falling through 12 feet, which could easily be effected. Pro-

bably the Bullock Power at the Powder Mills and Mint alone at present costs 8,000 Rupees per annum, which is the Interest of 1,60,000 Rupees, and with the command of a cheap power probably, its more general application to other purposes would result, and even in your establishments, it may be substituted for manual labor.

To enable you to form a calculation, I am desired to state that water for power could be supplied at say, 6,000 cubic yards for 1 Rupee, which if falling through 6 feet, would give a net power of 40,000,000 lbs. through 1 foot, equal to 13 Horse Power of a Steam Engine for 1 hour, and the cost would be $1\frac{1}{4}$ Anna per Horse Power per hour, but as the water would of course not be consumed by passing over a wheel, and as it would still be available for all ordinary purposes, some reduction in the cost may be effected.

The cost of manual labor may be taken at 2,000 lbs. × 60 minutes × 10 hours = 1,200,000 lbs. through 1 foot per day, and valued at 3 Annas which is 8 Annas for 1 Steam Horse Power for 1 hour, and Bullock Power may be estimated at about 4 Annas per Steam Horse Power per hour.

1 Bullock lbs. per day.
6,000 lbs. by 60 by 8 =2,880,000
per 4 Annas.

In making your calculation, it would be advisable to include not only the expenses of the Bullock Department, but also the losses from animals dying or becoming unserviceable, and also ascertain to the mechanical force in the different Departments of your Manufactory to which the labor of the Bullocks is applied, and compare it with the number of Steam Horse Power to which the labor of the full compliment of the bullocks is equivalent; also to contrast the total expenses incurred for the keep of the animal during the whole year, with the charge of the Water Power for only the number of working days, for although the water will require to be stored up as if to be used for the whole year, yet by its being known to be disused during a certain period of the year, holidays, Sundays, &c., the water not then required can easily be used for other purposes.

Any extra expenses or reduction connected with the machinery for Bullock and Water Power to be noticed. The cost of applying the water to work the present apparatus will not be great.

The advantage of applying an increased power when urgently required, in diminishing the Establishment, should also be calculated, as well as the superiority of the power in the work to be done, and any modifications in the other work now performed by manual labor to be taken into consideration.

I have the honor to be, Sir,

Your obedient Servant,

(Signed) A. H. HOPE,

Acting Secretary.

5th November 1852.

APPENDIX F.

TO THE SUPERINTENDENT GUN CARRIAGE MANUFACTORY.

Sir,—In forwarding to you the enclosed copy of a letter to the Superintendent Gun Powder Manufactory, on the subject of applying a Water Power to the works of the Gun Powder Establishment, the Board desire me to state they will be happy to receive your observations on the application of a Water Power to the purposes of your Manufactory, the great experience you have had will enable you to point out the application of this power to many purposes for which manual labor is now used, and the Board therefore abstain from making any suggestions as to the particular applications of the power.

I have the honor to be, Sir,
Your obedient Servant,
(Signed) A. H. HOPE,
Acting Secretary.

5th November 1852.

APPENDIX G.

Gun Carriage Manufactory,
Madras, 10*th Nov.* 1852.

FROM MAJOR J. MAITLAND, SUPERINTENDENT GUN CARRIAGE MANUFACTORY, TO LIEUT. A. H. HOPE, ACTING SECRETARY TO THE MILITARY BOARD, FORT ST. GEORGE.

Sir,—1. I have the honor to acknowledge your letter of the 5th Instant, accompanied by a letter No. 6782 to the Superintendent Gun Powder Manufactory, calling upon me for any observations I may have to make upon the application of a Water Power to the purposes of the Gun Carriage Manufactory.

2. The introduction of Water Power instead of manual labour for working the machinery at the Manufactory may be feasible. But I do not think it can be effected in the present state of the Manufactory, without introducing very great alterations both in the building as well as the machinery, and I am not at all sanguine, after giving the subject my best consideration, that the change meditated would be productive of any benefit to a Department like mine, where the work is of such an heterogeneous nature as to require manual more than any other description of power or labor.

3. The machinery at the Manufactory at present is on a very limited scale, and with the exception of the English Cast Iron Lathes is of a very defective description. The power required to set the whole of this small quantity of machinery in motion, when the Department is at its highest complement of

work, is the labor only of about 40 coolies, and as animal power is not employed here, the labor of the 40 coolies is equivalent to a Steam Engine of about 8 Horse Power, and the expense of the 40 coolies on an average is about 7½ Rupees daily, which is equal to nearly 2 Annas per Horse per hour, I do not see that much, if any thing, will be gained by introducing Water Power instead, when it is borne in mind that the manual labor, when not required for the machinery, can be turned into any other channel of usefulness, which will not be the case if Water or Steam Power is used; whether the whole or only part of the machinery requires to be wrought, the same amount of labor and expense must be daily expended.

4. Unless it is the intention of Government to extend the operations of this Department on a very extensive scale, I do not see any advantage in changing the system of labor at present pursued. It may prove beneficial to a Department like the Gun Powder Manufactory, where cattle are at present employed in turning the Mills and must be maintained whether the Mills are in operation or not; but in the Gun Carriage Manufactory, I do not think in the long run it would be of any advantage or saving to the State.

APPENDIX H.

Gun Powder Manufactory,
Madras, *7th Dec.* 1852.

FROM MAJOR T. LAVIE, SUPERINTENDENT OF THE GUN POWDER MANUFACTORY, TO THE OFFICIATING SECRETARY TO THE MILITARY BOARD, FORT SAINT GEORGE.

Sir,—In reference to your letter No. 6782, dated 5th ultimo, I have the honor to request you will do me the favor to inform the Military Board, that I have given the subject of applying Water Power at these Mills the fullest consideration. The proposition is not a novel one with me, I have had it on my mind for the last two years, but it has been burdened with difficulties as to a continual and regular flow of water, which I have not been able to overcome, but which the Board's project entirely remove.

I do not hesitate to say that the introduction of Water Power at these Mills would prove both beneficial and economical, beneficial in producing a superior Gun-powder, and lessening greatly the loss of life in cases of accident; economical as it would by reducing the strength of the establishment in human and manual labor very considerably diminish the cost of the Gun-powder.

I do not consider that any expensive machinery or apparatus would be required, the present buildings in which the incorporating mills are placed, and where Water Power would prove the most beneficial, are unfortunately not very well situated, but they might easily be altered or even re-built, using the present materials, at a very trifling expense.

The cost of working two mills during the official years 1851 and 1852, for human and animal labor exclusive of superintendence, amounted to Rupees 16,618-3-10; were Water Power introduced, I feel confident that the same work might have been performed, and I believe with greater efficiency, at a cost of Rupees 9,000, making a saving of Rupees 7,618-3-10.

APPENDIX I.

TO THE SECRETARY MARINE BOARD.

SIR,—A project being under the consideration of the Military Board connected with the supply of water for Madras, I have the honor to request you will furnish the Military Board with information as to the expense of watering the Shipping of the port, and the conveniences or difficulties in respect to supplying water, with any observations as to its quality.

The actual annual expense of supplying water under the supervision of the Marine Board will be a valuable data, and probably an estimate may be made of the quantity of water required annually by the shipping and the annual cost of placing it on board.

It would then be necessary to separate the charge for boat-hire from the cost for filling the water-casks and supplying the water—the difference being then the value of the water.

The Board are also requested to state whether any considerable increase in the demand for water would arise, if an abundant supply of water of a good quality could be furnished at a low rate; and in order to enable the Board to judge thereof, I am desired to state that if only the Interest on the Capital expended on the works to bring the water close to the sea being alone charged, water could be supplied to fill water-casks in the boats on the Beach at about one pice the 3,000 gallons of water, and the difference between this rate and the existing cost of water (estimated at present at about 14 Rupees for the same quantity) will afford the means of levying any additional sum requisite for repairs, establishments, without considerably increasing the cost of water to the Shipping above 2 pie per 3,000 gallons.

I have the honor to be, Sir,

Your obedient Servant,

(Signed) A. H. HOPE,

Acting Secretary.

5th November 1852.

APPENDIX J.

MARINE BOARD OFFICE,
Madras, *9th Dec.* 1852.

FROM JOHN J. FRANKLIN, ESQ., SECRETARY, MARINE BOARD, TO LIEUT. A. H. HOPE, ACTING SECRETARY TO THE MILITARY BOARD.

SIR,—With reference to your letter of the 5th ultimo, No. 6839, I have the honor by desire of the Marine Board to forward a Memo. showing the quantity of water supplied to the shipping at Madras during the last two years, on public as well as on private account, and the expense thereof, which is divided into the charge for boat-hire and that for filling the water. Similar data respecting the hire of the casks, which is a further charge of annas 9, pice 5 per boat, cannot be easily obtained, as Government almost invariably use their own, and private individuals do or do not according to their pleasure.

2. The water, which is of exceedingly good quality, is taken from a cistern in Clive's Battery, to which it is led from the Seven Wells; and the casks being previously placed in the boat, are filled by chatties. This occupies the time that would be taken in one trip, and it is on this account that the boat-hire is increased from one Rupee eight annas to two Rupees fifteen annas. If a hose were led into the boat, the operation of filling the casks would be considerably accelerated, and consequently the charge for boat-hire might bear reduction, while the cooly hire for filling would be saved, substituting a small fee in lieu for keeping the hose and its appliances in repair.

3. Adverting to the last para. of the communication under reply, I am desired to state that the Board are not of opinion that any material increase in the demand for water would arise from its being supplied at a cheaper rate than at present; for ships must take water and it is always customary to fill up. They are however fully alive to the advantage of placing this very necessary article of consumption within reach of the shipping at as low a rate as may be compatible with a fair remuneration to the suppliers.

Statement shewing the annual cost of Water, &c., from 1st January 1851 to 30th January 1852.

To whom.	No of Trips.	No. of Tons or quantity.	Amount of hire per trip at Rs. 3-8-0. Rs.	A.	P.	Amount of Owner's shares at Rups. 2-15-0. Rs.	A.	P.	Amount of hire for watering a Boat load, or a trip Rs. 0-9-0. Rs.	A.	P.	Remarks.
1851.												
Public Water.	111	222	388	8	0	326	1	0	62	7	0	
Private Water.	1,612	3,224	5,642	0	0	4,735	4	0	906	12	0	
	1,723	3,446	6,030	8	0	5,061	5	0	969	3	0	
1852.												
Public Water.	807	1,614	2,824	8	0	2,370	9	0	453	15	0	
Private Water.	1,516	3,032	5,306	0	0	4,453	4	0	852	12	0	
	2,323	4,646	8,130	8	0	6,823	13	0	1,306	11	0	

APPENDIX K.

MEMORANDUM.

The Military Board will feel obliged to the Chief Engineer for any information connected with the supply of water from the Seven Wells—the quantity supplied, the cost, and the extent of water supplied to individuals, and any remarks connected with the question of water supply from the Seven Wells.

I have the honor to be, Sir,

Your obedient Servant,

(Signed) A. H. HOPE,

29*th November* 1852. *Acting Secretary.*

APPENDIX L.

TO THE SECRETARY MILITARY BOARD.

SIR,—In acknowledging the receipt of your communication No. 6475, of date 20th October last, relative to the sanitary condition of Madras Patam and its populous suburbs, I have the honor under instructions from the Medical Board to acquaint you that immediately on the receipt of your letter, the several District Surgeons were requested to report on the subject with a view to obtain and present before your Board all the information that could

be brought to bear thereon. The Medical Board having reviewed the question and given to it their best consideration, I am desired to record the following observations for the information of your Board.

2. The Military Board in their letter under reply correctly observe, "that the absence of any registration of Births and Deaths prevents any accurate statistical data being obtained," which are essential to an investigation of the prevalence and causes of disease in any locality; but the Medical Board think they have sufficient upon the records of their office to enable them to form a tolerably correct opinion of the injurious influence on the public health, exerted by certain remediable causes which are now existent at Madras.

3. A concise but able report furnished to the Medical Board by Superintending Surgeon Godfrey in 1848, classes the subjects which require more especial consideration under the following heads: *cleansing*, *drainage*, *water supply* and *general ventilation.*

4. It is evident that all these heads embrace matter of very great importance; and if it can be shewn, that when any particular locality is deficient in one or other of them, there, disease is most frequently prevalent, it may on general recognized principles be assumed that the cause of sickness is to a certain degree known.

5. Beginning with the 1st District, Dr. Hunter in a comprehensive statement, dated 19th November last, distinctly proves that wherever sanitary measures are least perfect in Black Town, in the same locality disease is most frequent and *severe*. In the 2d District, comprehending New Town, Vepery, Choulay, &c., although considering its imperfections in drainage, ventilation, &c., it may be pronounced comparatively healthy, yet in the worst parts of it severe epidemic disease often appears, and much loss of life is the consequence; it is Mr. Kellie's opinion that these epidemics will increase in severity if no remedial measures are had recourse to. Similar opinions are strongly expressed by Mr. Sanderson, the medical officer of the 3d District, and though with less force, owing to short experience by Dr. Cleghorn of the 4th, the latter officer at the same time decidedly corroborates Dr. Hunter's statement regarding Black Town, of which locality he was formerly the medical officer.

6. The complete evidence above adverted to, joined to much of an earlier date and from other sources, leaves no doubt on the mind of the Medical Board, that the public health at Madras suffers seriously from a want of perfect sanitary arrangements; that exhalations from stagnant ditches, open

cesspools and decaying rubbish do exist, that although not positively general, they are so much so that nothing but a general system of perfect drainage, cleansing, and ventilation will be sufficient to obviate the evil consequences arising therefrom.

7. It does not appear to be within the province of the Medical Board to remark upon the plan proposed by the Chief Engineer for providing such a current of water as would constantly scour the *drains* and *sewers* of all the districts, whilst at the same time it would furnish an ample supply of the fluid for domestic purposes: further than to give their opinion, that if the project is successfully carried out, the advantages would be *very great.*

8. With reference to the question put by the Military Board in the 5th para. of their letter under reply, the Medical Board observe that they have no special information on the subject of water beyond what is generally known. Two chatties of water is probably about the average quantity used by each individual; many of the wells are brackish, but there are also several of good quality. The principal and best supply is said to be obtained from the Seven Wells near the Mint. On this subject the Board beg to refer to the reports of Mr. Sanderson and Dr. Hunter, which afford all the information they are in possession of.

9. The Board are not aware of the exact level of the large covered drains in Black Town, how far the *bottom* of these throughout their length is *above the level* of the Sea; it is probable that in some places the bottom of these drains may be on this level or even below it; and whether the supply of water proposed to be brought into Madras would efficiently scour drains thus placed, could only be determined by experience. They would advise in the meantime an increase of the Scavengers' department for the purpose of carrying the odure and rubbish away; an outlet to which may be opened up by boats on the Cochrane canal.

10. The accompanying original reports, six in number, are requested to be returned when no longer required.

I have the honor to be, Sir,

Your most obedient Servant,

A. LORIMER,

Secretary, Medical Board.

Fort Saint George, 31*st Dec.* 1852.

APPENDIX M.

SANITARY REPORT ON THE 4TH DISTRICT OF MADRAS, BY ROBERT COLE, ESQ., SURGEON OF THE DISTRICT, DATED MAY 5, 1854.

It is unquestionable that there are many circumstances in the peculiar character of Madras, which are at all times predisposing to affect unfavorably the Sanitary condition of its inhabitants—some of these are dependent on the natural configuration of the land, and others arise from the habits and practices of the inhabitants. These I will proceed to point out, with reference more particularly to the 4th District, or south-eastern portion of Madras; but I may mention that they are equally applicable to other parts of the Presidency.

There can be no doubt that the plan of Madras, at all times and under the most favorable atmospheric conditions, exhibits most of the elements which conspire to produce endemic diseases. It is almost a dead level of many miles area, and has become a *dense forest of cocoanut* and other trees, interspersed with fields under wet cultivation, and impervious plantations of sugar-cane, betel, plantains, &c. In all directions over this area are scattered native villages, with a dense population, the houses being thickly crowded and the streets very narrow, and I think it a very unfortunate circumstance for the salubrity of Madras, that the thickly populated places Triplicane and St. Thomé occupy the ground towards the sea coast, which is inaccessible to the inhabitants of the interior, except through approaches for the most part of a very filthy character, and the sea breeze is thus contaminated by the tracts it has to pass over. The gardens of the European residents form wholesome exceptions to the general rule, as they are airy and open, and more moderately planted with timber trees chiefly. The hedges surrounding them are, however, sometimes too high, and a regulation should certainly be introduced limiting their height, and regulating the cultivation and planting of the lands under native holders. I consider that the immunity from endemic and epidemic diseases which Madras generally enjoys, is attributed to the dry character of its climate, whereby the unhealthy influences enumerated above are in some degree negatived, but in the event of unusually humid seasons or under that peculiar constitution of the general atmosphere which produces the invasion of epidemic cholera or other diseases, there can be no doubt that we possess to an alarming degree all the elements likely to favor and to aggravate such visitations.

The Mussulman burial ground in Triplicane and St. Thomé, which lines the roads for long distances, the graves being in the very verge of the high way, cannot but be prejudicial to the health of the inhabitants.

The back-waters of the Adyar and some nullahs along the coast, particularly that at the entrance of St. Thomé from the north, form great

nuisances in some spots, from the noisome effluvia which emanate from their stagnant waters.

I would suggest attention to the following points, as likely to tend to the conservation of the public health.

1st.—Exuberant vegetable growth should be restrained by all possible precautions, and the dense plantations of native cultivators should be prohibited.

2d.—The number of approaches to the sea coast should be increased. The Beach may be truly called the "Lungs" of Madras, and a number of broad roads through the densely populated districts of Triplicane and St. Thomé, would tend to render more salubrious the latter place, and would form "arteries" through which might circulate to the interior the refreshing and healthful sea breeze. It will also be no small boon to the residents to have the beach rendered easily accessible from as many points as possible. I beg to point out as desirable directions for the opening of new roads—from the neighbourhood of the Club as straight as possible down to the sea: and from the Cathedral road, by Sullivan's gardens, down to the Barber's bridge and Masonic lodge. The road from the Luz to the beach of St. Thomé should also be widened in several places, as it is now a dangerous thoroughfare owing to its narrowness, and from the same cause the due circulation of air from the sea inland in that direction is impeded.

3d.—Some restrictions should be placed on the appropriation of land for Mussulman burial: places of interment for that class are scattered in all directions, and a year or two ago it was in contemplation to turn the grounds of the principal houses in Royapettah, which had become the property of a Mussulman, into a burial ground, as a lucrative mode of employing the land! I would suggest that the burial grounds should be limited to certain spots, and that they be surrounded with a wall, and a fringe of trees. If the present grounds could be abandoned, and places set apart more remote from the habitations of the population, it would be an excellent arrangement, and I beg most strongly to recommend that this should be done if practicable. Many spots might be pointed out, removed from the public roads and dwellings of the population, and yet not too remote for the transport of the dead by their relatives; with reference to this point, it may be appropriately mentioned here, that, owing to the strong expression of public opinion, a project to establish a burial ground in St. Andrew's church compound, was abandoned a short time ago, on sanitary considerations, and yet little or no check is placed over native places of sepulture. The Hindoo incremation grounds, also, might be beneficially restricted there are two within a short distance of each other

on the South beach, one of which might surely be abolished, and I would recommend that the one near Capper's house should be done away with, as a nuisance to the vicinity.

4th.—The embouchures of the *Adyar*, the nullah to the north of St. Thomé, and a smaller one further up the coast to the north, form public nuisances, owing to the noxious effluvia proceeding from their stagnant waters, which spread in shallows over a great extent of ground. This might be removed in a great degree, if not altogether, by deepening the central channel, and bringing the soil to the sides near the public roads. Below the Elphinstone bridge it would be desirable to remove the mud banks in the mid channel, and therewith raise the ground on either side, so that the waters should not spread out and stagnate. The nullah north of St. Thomé is of a most offensive character, and the noxious effluvia are increased by employing the Scavengers' carts on the side thereof partly in the water, so that decomposition of animal and vegetable matter goes on, and the most noisome exhalations are the consequence. Here it is very desirable to deepen the mid channel, and I think if a large and deep tank was dug in the centre, it would form a reservoir for the water, and prevent the stagnant shallows which now exist near the public thoroughfare from Triplicane to St. Thomé. The latter place being a *sanitarium* to which British families resort for the sake of their health, all unwholesome objects should be removed from the vicinity.

5th.—The drains in Triplicane are offensive in the extreme, and require alteration and remedy, those near the Triplicane dispensary at the cross roads leading to the Ice house, particularly call for notice. An increase to the number of Scavengers is much called for, and a more frequent and complete cleansing of the drains in these localities is very much required.

APPENDIX N.

REPORT ON THE SANITARY CONDITION OF THE 2ND DISTRICT, BY J. KELLIE, ESQ., SURGEON OF THE DISTRICT, DATED MAY 6TH, 1848.

SIR,—I have the honor to reply to your letter of the 21st March, calling for information, regarding the sanitary state of the 2d District.

Since the receipt of your letter, I have instituted enquiries as to the general state of health of this portion of Madras, and combining the information obtained, with what I had previously become acquainted, as the medical officer of the district, I can with tolerable confidence offer an opinion on the subject, and as a whole, I believe the 2d District to be one of the healthiest parts of the Presidency. It is true that there are periodical visitations of cholera in certain

localities, and that fever to a serious extent also occasionally prevails, but generally speaking, the district is comparatively healthy ; diseases which often prevail in an epidemic form elsewhere, such as dysentery, small pox, continued fever, &c., are here not often met with, and there are no diseases which can be considered endemic to the district, with perhaps one exception, dracunculus or guinea-worm.

This opinion is I am aware opposed to what is generally understood, or what might be expected by any one only acquainted with the external appearance of the district; for a certainty it contains within itself to an extent seldom met with, all those causes which are acknowledged to produce premature old age, disease and death—viz., a dense population and its usual concomitants, insufficient ventilation and extreme uncleanliness, the sewerage and drainage are of the very worst description and the scavengering is most imperfectly performed; indeed as far as my own observations go, the work performed by the Scavengers is to carry off the refuse of the town, from the more public streets and to throw it down in any hole or corner close at hand, but less exposed to the public eye.

There are 4 burying grounds within the limits of 2d District—viz., 2 in Vepery and 2 in Pursewauk. I have been unable myself to trace any disease to the noxious influence of these grave-yards, but as they are stituated in low and damp localities and in the midst of a dense population, I have no doubt but they do at times exercise an injurious influence on the health of the community, and it was the opinion of my predecessor Doctor Richmond that they did do so.

The quantity of vegetation about the west and north side of the district is such as seriously to impede the free circulation of air, and thus ventilation is obstructed in a quarter where it is most essentially required; this growing evil is becoming one of such magnitude as will soon force itself, from its injurious consequence upon the health of the community, on the serious attention of the authorities. As the district is divided into three divisions each presenting some peculiar feature as regards its sanitary condition, I will offer a few remarks on each, beginning at the west end of the district.

KILPAUK.—This division contains comparatively few native inhabitants; the villages are small and at a considerable distance from each other, there are here numerous excellent gentlemen's houses surrounded by large compounds ; cocoanut trees abound in this part of the 2d District, every compound contains them and extensive plantations are springing up in every unoccupied space. No sooner does a house become the property of a Native or East Indian than he plants the compound with cocoanut trees, and so dense are some of these plantations that they form a barrier perfectly impervious to the sea or land

breeze; the house in consequence is soon rendered uninhabitable, falls into decay and rank vegetation springs up around. This is no fanciful picture; several houses in my immediate vicinity are thus situated, untenanted, ruinous, and surrounded by cocoanut trees and jungle, what applies to them will in a few years be equally applicable to every large house in this division, for the evil is rapidly increasing; discomfort and insalubrity must be the necessary consequence of the absence of pure air, and thus the European inhabitants will be driven from Kilpauk, valuable property deteriorated and visitations of cholera in the adjoining division of Pursewauk rendered more frequent, less easily removed and more fatal in its results.

The Female Asylum in the immediate neighbourhood cannot be expected long to continue uninfluenced by the evils above alluded to. The children belonging to it have hitherto been extremely healthy, but in proportion as these plantations are allowed to surround and encroach upon the Asylum, so will the salubrity of this admirable institution be affected and to a certain extent its usefulness impaired.

The native villages in Kilpauk are extremely filthy, and no means are used by the inhabitants for the removal of the animal and vegetable refuse with which they abound.

PURSEWAUK.—This division forms the central portion of the district, lies low, with a slight declination from the Poonamallee road to the Outry nullah. It is densely populated with Natives and East Indians: the upper portion is well built and the main and intermediate streets are kept clean, but as you approach the nullah or north side of the division, the houses or huts are of the most inferior description and are inhabited by a crowded and most filthy population.

The sewerage and drainage of Pursewauk are of the very worst description, indeed any thing of the kind can scarcely be said to exist, few if any of the gutters are continuous, of the same depth, or paved; thus the liquid filth of the inhabitants, issuing from the house drains lodges in the hollows in front of the dwelling, and it is only by the natural process of evaporation and absorption that it is ever removed; wherever cattle are kept, there the evil exists to a greater extent, and the natives themselves, even the most respectable, use no means whatever to remove this disgusting nuisance from their doors.

The scavengering is very imperfectly performed, more particularly in the very localities where filth most abounds, viz., in the narrow streets and lanes where the poorer classes reside and where ventilation is most deficient; here animal and vegetable refuse is allowed to collect for several days before it is removed, and not infrequently the refuse of the main streets is thrown down in these less frequented localities.

From what I have stated, it is not surprising that cholera makes a periodical visit to Pursewaukum, and that during the last months of January and February 225 were carried off by it: besides cholera, fever and other diseases often prevail in this neighbourhood, but none of them to a greater extent than might be expected in such a crowded locality.

VEPERY.—This division is densely populated, a large proportion of the inhabitants being Europeans and East Indians. The Natives reside on the north side of the district—a low badly-drained locality, the streets are narrow, filthy and ill ventilated, and altogether it might be expected to be the very focus of disease.

The low level of the ground necessarily renders the drainage very imperfect, and after rains almost every compound becomes a stagnant pool and fluid filth collects in every street. In this division many of the gutters are paved with brick—but either from the natural difficulty alluded to, or carelessness on the part of the inhabitants and Scavengers in allowing the drains to become obstructed, the dirty water is allowed to collect and stagnate in the gutters, and the drains seem more a receptacle for the fluid filth of the community than a channel for its removal.

In the very centre of this neighbourhood some of the drains actually terminate in a large tank, which seems now half full of liquid filth.

The northern portion of this division is extremely filthy, and no effort, certainly no efficient one seems to be made for the removal of the animal and vegetable remains which everywhere abounds—the smell is most offensive and it is difficult to conceive how people can exist in such an atmosphere. Sickness to a considerable extent prevails in this division and it is in such localities that cholera usually first appears and afterwards spreads into the more respectable portions of the town.

The principles of sanitary improvement are now so universally known and acknowledged that it would be a work of supererogation on my part—(having stated the causes of sickness which abound within the limits of the 2d District), to do more than simply allude to measures which I would recommend to be adopted for the improvement and preservation of the public health, but I cannot refrain from stating that very serious consequences may reasonably be expected, unless more efficient means for the prevention of disease are adopted. The evil effects on the inhabitants residing in such a locality and breathing at all times such a noxious atmosphere may not to us be very apparent, but we have no reason to believe it innocuous. It invariably produces an ill-conditioned state of the body, deteriorates all its functions and causes a susceptibility to the impressions of contagious and epidemic disease.

The description of fever which has hitherto prevailed has been *intermittent* and *remittent*, caused by the swampy nature of the ground and the decomposition of animal and vegetable remains, but when I see in so many quarters of the district, in such a concentrated form, every combination which is acknowledged to be a prolific source of disease, may we not reasonably expect, (perhaps on the occurrence of some atmospheric change) the generation of a fever of more malignant character ; such occurred some years ago in Central India, when fever of a malignat character broke out in the filthy commercial town of Palli. It became highly contagious, very fatal, and presented all the symptoms and external features of the plague.

In conclusion, I beg to offer the following suggestions for improving and preserving the health of the inhabitants of the 2d District.

1st.—The erection of public necessaries.

2d.—Filling up of all hollows and small tanks. After the rains the water in these tanks and hollows soon becomes stagnant and they also form a receptacle for all the liquid filth of the neighbourhood.

3d.—Adopting more efficient measures of the cleansing of the streets and side streets drains.

4th.—Compelling every inhabitant to keep clean his house drain, preventing him throwing animal or vegetale refuse into the streets drains, and obliging him to have cleansed once a day the gutter in front of his own dwelling.

5th.—Preventing the planting of cocoanut trees, without permission, within a certain distance of Madras ; cutting down of all hedges to the height of 4½ feet and removing from all compounds superfluous vegetation.

6th—Regulating the building of all houses, so as to produce a uniform width of street and continuous street drain. This would prevent the formation of parcherries of which there are many in Pursewauk and which are composed of huts crowded together and densely populated ; it is in these ill-ventilated filthy spots where cholera I am informed usually first makes its appearance.

In conclusion, I beg to add that I shall be happy to afford you any further information which you may require on this very important subject.

APPENDIX O.

Madras, 18*th May* 1848.

FROM SUPERINTENDING SURGEON F. GODFREY, TO THE CHIEF MAGISTRATE AND SUPERINTENDENT OF POLICE, MADRAS.

Sir,—In forwarding the accompanying Sanitary reports of the medical officers attached to the four Districts into which Madras has been recently subdivided, I do myself the honor to call your attention to the subject as one of paramount importance in reference to public health.

It is unnecessary for me to make many remarks, the Reports having been so ably and explicitly drawn up by the District Surgeons.

The nuisances which have been pointed out as a probable source of direct disease—are accompanied with the sad reflection—that the medical officer can do little more than administer to effects, whilst the causes are suffered to remain.

The residence in these malarious localities may not seem or be considered by some to be a cause of direct disease, yet it appears to me more than probable that the general tone of the system is hereby reduced, and a predisposition engendered to receive the impression of any epidemic poisons or other occasional disorder of the system.

With regard to the actual mortality and nature of prevailing diseases, I have no accurate means of judging, as official Reports on the subjects (though very desirable) are not forwarded to the Superintending Surgeon's office, except occasionally in a general form by medical officers, when cholera exists epidemically; this precludes me from forming a comparison of the sanitary states of Madras with reference to European cities where accurate Registers are kept and publicly recorded.

The circumstances which the accompanying Reports advert to as requiring consideration may be arranged under the heads—Cleansing—Drainage—Water supply—General ventilation.

Under the head *Cleansing* may be noticed the highly offensive state of the drains, the imperfect manner of cleansing and the removal of the collected filth to the banks of the river and other ill-selected places; then the offensive and disgusting exhibition of hundreds of human beings exposing their persons for the purpose of defæcation near to each other, within limits of the Supreme Court—and close to public thoroughfares is an occurrence that would not be tolerated in any really civilized part of the world, and must be a source of lowering the morals of the people and productive of the usual concomitants—

debauchery and sickness as well as rendering the surrounding atmosphere impure and a very probable source of direct or indirect disease.

The Native burial grounds are also in many instances badly situated in populous localities and the graves not of a depth sufficient to ensure the air from being tainted by the decomposition of the bodies.

2d. DRAINAGE.—For this purpose it would perhaps in the first instance be advisable that Madras should be surveyed and correct levels taken—and then might be ascertained the practicability of raising water by steam or other means for cleansing the drains particularly in Black Town, and the propriety of having them reconstructed and covered in conformity with the usage which obtains in Great Britain.

3d. WATER SUPPLY.—The only drinking water considered as unexceptionably good in Madras is conducted by means of underground pipes from the "Seven Wells" close to the Mint at the northern extremity of Black Town to the esplanade and fort; the public are not allowed to use this water unless on making payment of half a rupee per mensem for a cavady load daily. This tax may be considered injurious as tending to induce poor people to drink the less pure and brackish water which everywhere abounds in Madras. It appears therefore highly advisable—for public health, that water of the best obtainable quality should be gratuitously and easily accessible in many other localities than those to which it is at present confined.

4th. VENTILATION.—This perhaps might be obtained by lowering the hedges, cutting down many trees, limiting the cultivation of such articles as require an artificial swamp for their growth (sugar-cane, rice, &c.) and opening wide roads from the interior seawards in directions best adapted to admit freely the prevailing winds.

APPENDIX P.

MADRAS, *19th November* 1852.

FROM ALEX. HUNTER, ESQ., M. D., SURGEON, 1ST DISTRICT, TO T. KEY, ESQ., SUPERINTENDING SURGEON, PRESIDENCY.

Introduction.

SIR,—In reply to your letter No. 441, dated 25th October 1852, enclosing a letter from the Secretary to the Military Board, regarding some contemplated improvements in the Drainage and Sanitary condition of the town of Madras, I have the honor to inform you that I have been able to collect some important information, regarding the condition of the town, which I shall attempt to arrange in order for the information of the Military Board under the heads of—

Heads of Report.

1. NUISANCES.
2. DEFECTS IN THE DRAINAGE, SEWERAGE, AND SUPPLY OF GOOD WATER, AND
3. SANITARY CONDITION OF THE TOWN.

Nuisances. Stagnant water.

1. NUISANCES.—Under this head may be classed the stagnant ditch, running along the open plain from a little in front of the Sailors' Home to the bridge near the General Hospital. The Cooum river and commencement of the canal, the fort ditch at some seasons of the year also become very offensive. There is a large sheet of shallow stagnant water about the middle of Popham's Broadway on the east side, another behind some huts on the opposite side of this road, a third in Davidson's street, a fourth in a cocoanut tope, beside the Female Orphan Asylum, and immediately opposite this institution is a small tank usually in a filthy state. In addition to these large collections of stagnant water, there are numerous localities where water lodges for some time after showers of rain. Amongst the nuisances may also be classed the banks of the Cooum river, the open country round the town, the privy drain from the House of Correction, opening out near the Monegar Choultry, and the sandy beach at Royapooram, all of which are used as open privies, or places of public resort which are never cleaned. There are also dung heaps and collections of rubbish in several dilapidated or deserted corners, and as soon as a house

Dirty tanks. Open privies. Dung-heaps

is dismantled, or uninhabitable it is converted into a cow-shed, a stand for horses, or a dunghill. The keeping of large numbers of cows or bullocks, and the feeding and rearing of pigs in town, is also a nuisance which has repeatedly led to the outbreak of severe epidemics, in two or three localities which will be noticed hereafter. The tannery and killing market in Vencatachella Iyer street, with the adjoining tank in Movis Khan's garden into which all the filth from the tannery runs, are very serious nuisances, which ought unquestionably to be put a stop to. The large accumulations of cows and horses' dung which are frequently to be seen in Linga Chetty street, Angapen Naik street, Annasawmy Moodelly street, and a few other localities, where bratties (dung-fuel) are prepared, must prove highly detrimental to the health of the neighbouring population. The filthy over-populous and confined state of a few of the streets in town, as Moor street, and a few of those to the west of the Market and the Justices' jail are also points which are worthy of consideration, should any improvements in the drainage of the town be carried into effect, as low damp localities like these are the hot beds of disease and misery. I have thought it advisable to class all the nuisances together arranging them under one head, as their effects may be neutralized to some extent, by a plentiful supply of fresh running water. No one can doubt for a moment that the above nuisances are the cause of a great deal of sickness, and were it not in spite of them that Black Town is rendered salubrious from its being immediately within the influence of the sea breeze, under any other circumstances the mortality would be very great. As it is, I have remarked that after a long continuance of any one kind of weather, particularly during the summer and autumn months, when the sea breeze fails, sickness invariably increases and that it is often suddenly checked by a change of wind, particularly if accompanied by a storm. I have also remarked that the exhalations and offensive smells are more perceptible during the prevalence of the land and long shore winds, the sea breeze apparently having the power of neutralizing or modifying them to a considerable extent. This may depend upon the change of electric condition of the atmosphere, or its increase of density from being cooled. The seasons of the year during which sickness is most prevalent in Madras are March, April, August, September, and beginning of October. Dry seasons appear on the whole to be more sickly than wet ones, and cholera, fever, and rheumatism are in general

Cow-sheds.

Piggeries.

Tannery, and killing market

Manufacture of bratties.

Dirty streets.

Sea breeze renders town salubrious.

When sickness increases.

Exhalations when most perceptible.

Sickness when most prevalent.

most prevalent immediately before a storm; in fact I have begun to look upon these three diseases as good barometric indications of the state of the atmosphere, and there is no doubt that they are caused by noxious exhalations conjoined with certain states of the weather, as we find them passing into each other, and always assuming the most virulent forms in low crowded, or damp and filthy localities (for proof see reports under the head of the Sanitary condition of the town.) That the deleteri-

Exhalations extend their deleterious effects to other districts.

ous effects of the exhalations from some of the above nuisances are not confined within the limits of Black Town is proved by the frequent prevalence of cholera in Shoolay, and the adjoining parts of Vepery, which have the additional nuisance of the sea breeze tainted with the exhalations from the banks of the canal, and from large droves of bullocks, cows, sheep, and pigs, which are daily kept in great numbers on the plain in their vicinity.

Healthiest months in the year.

The healthiest seasons of the year, appear from the hospital records to be, June, July, November, December and January.

Drains and sewers of Madras.

2 DRAINS AND SEWERS OF MADRAS.—It is unnecessary to enter at any length into the subject of the drainage and sewerage of the town, as their defective condition is already well known to the authorities. There are one or two facts connected with them, which it may not be out of place to mention, as they might

Raised parts of the Town.

require to be taken into consideration hereafter. The town has two distinct elevated ridges, the one extending from the Mint in a southerly direction towards the General Hospital, and sloping down with a very gentle declivity of only a few feet, for some hundred yards on either side; the other ridge extends along Armenian street towards the Royapooram gate with a fall of 6 or

Low parts of the Town.

7 feet towards Popham's Broadway on one side, and of 3 or 4 feet towards Moor street from which there is another slight rise towards the beach; advantage has been taken of these undulations in constructing the open drains and main sewers, but from the latter being at or below the level of the sea, their utility is

Large sewers get clogged up.

neutralized throughout the greater part of the year, as it is only after any heavy showers that they get washed out.

Mode of cleansing the drains objectionable.

The mode of clearing the large drains by cooly labour is most barbarous and objectionable, as it has on more than one instance led to the suffocation of coolies who were employed, and the throwing of great quantities of black fœtid liquid slush on the roads is highly detrimental to the health of the population, and offensive to persons passing along the roads. There can be no comparison be-

tween the efficiency of the mode of cleaning drains by constant running water, or by the labor of Scavengers, and in the event of the former plan being adopted, I am of opinion that the only way in which it can be effectually carried out is by trusting more to the small surface drains, as is done in the streets of Calcutta, and discarding the present deep large sewers, which can only be kept in an efficient state by giving them a considerable inclination; another point which requires consideration as materially affecting both the health and comfort of those residing on, or near the beach, in the houses facing the esplanade, and within the fort, is the discharge of the putrid contents of the drains into the surf. It is true that this appears to be the quickest and readiest way of getting rid of the filth of the town, but when it is proved to give rise to sickness of a dangerous kind, in the above localities,* and to be offensive and annoying to the public at certain seasons of the year, attempts should unquestionably be made to give a direction to the drains which would lodge their noxious contents beyond the reach of injury to the health of the population of Black Town or its suburbs. With a little management and the application of chemical and agricultural skill to the concoction of manures, this refuse foul water with old mortar, ashes, and dry rubbish from the town, might be converted into good saleable manure, for which a price might be obtained by contract, as is done in the vicinity of many large towns in Great Britain and on the Continent.

Running water through drains desirable.

Filth of the Town carried down to the beach.

Drains ought to be carried inland.

Their contents used for manure.

3. SANITARY CONDITION OF MADRAS.—As regards the Sanitary condition of Madras, there can be no doubt that the project now under contemplation of improving the drainage and sewerage of the town, and of supplying a current of water through the drains would tend most materially to improve the health and cleanliness of the town. The localities which are most in want of cleaning are Popham's Broadway throughout at least ¾ of its extent, Moor street, a dense nest of houses in the street behind the Rev. John Anderson's school, another near the Market extending from Annasawmy Moodelly street along the west side of Rattan-man's street to the esplanade. In the two latter localities great numbers of cows, bullocks and horses are kept; the places where they are housed are never thoroughly cleaned out, and there are constant putrid exhalations from them, which can be perceived both in dry and

Sanitary condition of Madras.

Localities requiring to be cleansed and thoroughly drained.

Feeding of cows, bullocks and horses, leads to sickness in the vicinity.

* See Reports on Sanitary condition of Madras.

wet weather. The consequence is that these localities are the most unhealthy in town, and in some of them there have been severe epidemics of cholera, fever and rheumatism. The streets leading from the Market, and from Anna Pillay street to the esplanade near the Sailor's Home, and Patcheappah's hall, are never free from fever, and during the last three years there have been repeated and severe epidemics of this disease and of diarrhœa in the above locality, and in Conda Chetty street which is also very unhealthy. The causes are a large public privy and the burying ground of the Roman Catholic Cathedral, from both of which I have repeatedly perceived putrid effluvia. During the last three months there has been an epidemic of very severe intermittent fever in the streets from the north corner of the Market, and the Wesleyan chapel, extending down to the beach, where there have also been some bad cases. This I attribute to the effluvia from the open drains. I have remarked that the localities where cholera generally first makes its appearance are the nest of houses behind the Rev. John Anderson's school, the north end of Moor street, and the centre of Popham's Broadway. This corroborates the observation that has lately been made regarding the disease in Europe, viz., that low damp situations are those in which it is most prevalent and virulent. Madras is seldom visited for any length of time with severe epidemics of cholera, but there have been occasions where the disease has been very fatal as in 1837, and there is not a year during which a few cases do not occur.

Fevers where most prevalent.

An epidemic of a bad kind lately prevalent.

Cholera, where it generally makes its first appearance.

Cholera, a severe epidemic in 1837.

Another point connected with the Sanitary condition of Madras is the narrowness of many of the streets and their general direction from north to south; should any changes be hereafter contemplated in the removal of over-crowded huts, it might be as well to open up some broad streets in a direction from east to west, so as to admit the sea breeze freely into the centre of the town. As a proof of the advantage of broad streets, I may mention that the healthiest parts of Black town and its suburbs, are the Parcherry and Tondiarpett. In the former there are a good many broad streets running east and west and both localities are kept in a cleaner state than most other parts of the town.

Narrowness of streets, and their general direction.

More cross streets required in town.

The only other point upon which the Military Board are desirous of obtaining information is the supply of good water, and the localities from which this is obtained. I have taken

Supply of good water.

the trouble to visit most parts of the town to satisfy myself regarding the state of the wells, drains and supply of water, and I find that the only places where good drinking water is procurable are the Seven Wells, and their branches which supply the House of Correction, the Male and Female Orphan Asylums, the Grand Jail, a well besides Messrs. Parry and Co.'s office on the beach, two on the esplanade, and several in the Fort. There are also wells of pretty good water at Royapooram, the Monegar Choultry, and Veerasawmy Pillay street in John Pereiras, also near the Elephant gate, and in Thumba Chetty street. The usual daily consumption of good water by a family is two chatties, for which 4 to 12 Annas a month is paid according to the distance. Several of the wealthy natives employ a cooly to draw a water cask for which the pay is from 1 to 2 Rupees monthly with food; most of the native houses have wells for common water, but the number of public wells of good water is not sufficient.

Wells in town supplied from the seven wells

Other wells of pretty good water.

Usual daily consumption of good water.

Trusting that the above report which has been drawn up from actual observation and examination of the records of the district, may prove of service in the contemplated improvements of the Sanitary condition of Madras.

APPENDIX Q.

REPORT FROM H. C. CLEGHORN, ESQ., ACTING SURGEON 4TH DISTRICT, IN REFERENCE TO WATER AND DRAINS.

Having recently joined this District, I have not had much practical acquaintance with any local causes which are instrumental to the occurrence of disease. I have traversed St. Thomé and Triplicane in every direction, taking counsel with the Chief Magistrate, and seeking for every information with reference to those important sanitary questions which form the subject of the Military Board's letter; I proceed to point out such circumstances as have come under my observation in the south-eastern portion of Madras, and some, which are still more apparent in Black Town, where I was lately stationed.

2. The undoubted authority of evidence derived from all classes of observers, in different countries, proves that *low* situations and *dirty* localities are the places in which disease is most prevalent and fatal; my duties for eight months in Black Town, enable me to corroborate this statement, and to declare that cases of sickness were mostly found where cleansing operations were most required, where the greatest quantity of organic matter was in a state of decomposition.

3. The sewerage of the town is then of the first importance in a sanitary point of view, and there is no question that the drainage of some parts of Madras is in a defective state, giving birth to morbific causes which would probably engender endemic and epidemic diseases, if these were not counteracted in some measure by the dryness of the climate, the prevalence of the sea breeze, and the porosity of the sandy soil which last is very advantageous in removing offensive materials by an agency within itself, and prevents the corruption of the atmosphere.

4. The drains in Triplicane are sometimes offensive at the crossings of narrow streets, (which might be regulated in future as to breadth by a distinct enactment,) and a more frequent and thorough cleansing of them would be a great improvement, particularly in the hot months, when there is no flow of water to carry off the offensive matter lodged in them, which here and there accumulates and stagnates, to the injury of health, and the annoyance of the surrounding population ; however I may state that the effluvia is only occasional, and no where at all to be compared to that arising from the main drain of Black Town, which may be termed the "*Monster evil*" of Madras, in a sanitary point of view, and which I have no hesitation in saying ought to be flushed from time to time with a sufficient quantity of water to carry off the offensive matters lodged in its bed. These accumulate and present the appearance of an enormous pestilential cesspool, from which putrid exhalations are continually rising towards the windows of the adjacent houses in the esplanade.

5. The surface water of Madras loaded with many matters in suspension and solution, percolates through a bed of fine sand, and comes out of deep wells or tanks, brilliant, and in every respect good, having been purified of the obnoxious matter by a natural process of infiltration. Some of the wells near the sea are brackish, and the water of several I have found destructive to vegetable life, so that even the supply for gardening purposes has to be brought from a little distance; other wells in the vicinity of the Mahomedan burial-ground are charged with organic principles, and the water is sometimes covered with a greasy scum and is not even wholesome for bathing : but taken as a whole, the district is well supplied in ordinary seasons, and there is no general want of good water for domestic purposes, the district being in this respect more favorably circumstanced than Black Town, where a supplementary supply of water would be very valuable to the inhabitants.

6. Some cases of chronic dysentery have occurred in the 4th District, which may fairly be attributed to the drinking of unwholesome water out of tanks generally muddy, or choked up with different species of weeds ; but this evil only admits of remedy by cleansing the tanks, for in many

instances I believe the women would still frequent the tanks though water was introduced to their dwellings by pipes.

7. In a district so extensive, full of scattered villages, it is difficult to see how water could be universally introduced without incurring very great expense. As regards the total amount of water consumed in houses, I regret to say that, after many enquiries, I have failed in obtaining sufficient data for a safe estimate.

APPENDIX R.

REPORT FROM J. SANDERSON, ESQ., SURGEON 3D DISTRICT, TO THE SUPERINTENDING SURGEON, PRESIDENCY, DATED MADRAS, 13TH DECEMBER, 1852.

SIR,—In accordance with the instructions received from you, under date 25th October, forwarding at the same time a letter from the Military Board, I have instituted inquiries into the sanitary state of the native villages within this district, and I have now the honor to detail the information acquired, with a few observations that appear to me to be the natural result of them.

Within this district there are the following native villages, Chintadrepettah, Poodoopettah, Comaleespuren Covil, Munnasawmy Covil, Narsingapooram, Egmore, Mackay's gardens, and Nungumbaukum consisting of two villages.

The first in importance is Chintadrepettah; this village is supposed to contain 24,497 people, occupying an area—intersected by streets of considerable breadth, running both south-east and north-west, and north and south generally, none of them being in good repair, on each side of the roads and between the verandahs of the houses (that are generally not of greater breadth than four feet), the principal drains are placed constructed of the ordinary brick, covered over with chunam of 2¼ feet in depth, and 2 in breadth. With no exception am I able to say that they are in a good state; but on the contrary, are in the greatest state of disrepair, the bricks being denuded of chunam and presenting a porous, absorbent and unequal surface, thereby retaining a large quantity of the filth, that would otherwise be taken away by the Scavenger department, and from the proximity of them to the houses of the people, must tend to deteriorate health by the emission of so noxious a vapour, that must be sent forth on the sun's rays reaching them.

It may not be beyond my province to say, that the construction of the drains are deficient, not only in the material made use of, but also in the mode of their construction; to rectify the former, a glazed material should be used, if they are still to be kept as open drains, or iron pipes, if the opposite kind is considered preferable: but in order that they may be kept clean, a large supply of water must be used, and how this is to be obtained, forms one of the most prominent features in this inquiry. It is a subject that I can only speak of with great diffidence, doubtless the supply is much needed; but it is a matter of some doubt in my mind, whether the supply cannot be obtained by making use of the large quantity that is at present within the reach of the people, instead of resorting to the plan, which I believe is in contemplation, of bringing it from a great distance.

It is well known to all, that attached to every third house on an average, there is a well; that though the quality of the water for culinary purposes is not good, yet it is made use of for bathing, washing, &c.; and may I ask, could it not be made use of, under municipal authority, for keeping the drains clean, by each house being held responsible for the cleanliness of the part of the drain that is in its proximity; or on the other hand, would it be better for the purpose of drainage and the people themselves, for the public authorities to give the supply, obliging the people to pay for the same by the levying of a tax; to my mind, the former plan is more desirable than the latter: the better class of people of this country, who are generally the inhabitants of these houses at the present time, may be induced by the degree of responsibility that is thrown on them, being called on to keep their neighbourhood cleanly to do so, and the very natural principle of the influence that one person, who is of cleanly habits, would have on those who are not so, will be called into play, and this can also be enforced by authority. I am fully aware that these remarks will only apply to that class of people who are occupants of the better smaller houses, and not to those much reduced in circumstances, or to the people who are only living in huts closely packed together, and who have no wells attached to them. In Chintadrepettah there is no want of both of these—one part, to the south-east of the village, and between it and Mr. Burghall's Stables, there are many huts clustered together, the lanes between the rows of them not being above four feet wide—the huts themselves being of a most miserable character, not only surrounded with all kinds of filth arising from the decomposition of both animal and vegetable substances, but built on ground that has been formed by the system at present adopted, of filling up all places that are lower than the adjacent parts, with the refuse collected from the streets by the Scavenger department. This system is in my opinion most objectionable for such a purpose, and cannot but have a most noxious influence on all those who reside within its influence: surely if the refuse is not considered fit to

remain when in a loose and scattered state, it cannot but be much more objectionable when accumulated in large heaps and made to form the sites of so many houses. It has also been made use of for the purpose of making public roads, that encircle the whole part of the populous village. It must have been forgotten that substances of such a heterogeneous nature must undergo decomposition, and that the quicker that this state is hurried on, the less noxious it becomes, whereas the very opposite plan is adopted, cart-load after cart-load is heaped on each other, and at last roads and sites of houses are made to the extent of eight or twelve feet in depth, that must require years before the accumulated substance can have ceased to emit what it contains within.

With the view of improving the more densely populated part of this village, where the inhabitants are living, in as low a state of animal existence as they can well do, I would beg to suggest, that streets should be made through these closely populated parts of all the native villages, free ventilation would be thereby obtained at least: and to enable the poorer classes to have the benefit of cleanliness, the system of wells in those same places should be placed at their disposal, either by digging for them where they do not exist, or the right of those that are already in existence purchased by authority, and a free use of them given to all the inhabitants. This would counteract much of the evil that now emanates from such places, and the malignant diseases that in nine cases out of ten, take their rise in those places, would be mitigated, if not got rid of. I would next call attention to the fact, that nearly in the centre of this populous village, are shambles, 3 in number. It will not be necessary to point out in the present day, what a most deteriorating influence these must have on the health of all those inhabitants who live in houses adjacent to them, and that they themselves attribute much sickness to their presence, and rightly too, for to visit them once is sufficient to make an impression both on the mind and nasal organs, that requires days to get rid of.

A better system of necessaries is also required, in this village. It is also most advisable that all those buildings that are in an uninhabited state, from the walls having tumbled down, when the proprietor will not repair them, should be removed. At present they are only the centre generally of luxuriant vegetation where filth of all kinds is allowed to accumulate ; this state of buildings is frequently met with in this village, no doubt the right of private property will interfere with this, but as has been done at home, a municipal act would at once settle the question. It is also most advisable to oblige the inhabitants to alter the present system of keeping bullocks, and all other animals within their own dwellings—a practice which only requires to be mentioned, to be condemned, not only on account of the dirt that must accumulate in conse-

quence, but from the tendency that such a system has of debasing the minds of the people.

I would beg to suggest that the system of village schools be adopted amongst the poorer portions of the villages. I feel confident that this country, in that respect, differs little, if any, from Great Britain, and it is well known to all, that great benefit has attended the system, of placing schools in the most thickly populated parts of our large towns.

With reference to that part of the letter referring to the appearance of the sea after rain, it must be borne in mind that much of that appearance is to be attributed to the dirty state of the roofs of the houses as well as to the drains.

The quantity of water made use of on an average by each individual, I am informed, is two pots per diem, equal to 24 measures, or 2,400 cubic inches, including half a pot for drinking purposes; which in this village is obtained from Egmore, a distance of 1¼ of a mile, or from Nungumbaukum a distance of nearly 3 miles, there being no good water to be met with in this locality, though as I have said before abundance for other purposes. The cost from the former place is one pice per pot, from the latter it is two pice.

COMALEESPUREN PETTAH.—The preceding observations apply with even double force to this native village. There is one ditch running between the main road (Pantheon) and the native huts where all the filth is thrown into, and where there are to be seen large numbers of pigs constantly running about; this place is known to be very frequently visited by cholera. In both of the above named villages, guinea-worm prevails, at all events is observed, especially in the hot weather.

NARSINGAPOORAM—requires also to be looked into, as all the causes of disease already mentioned, are in full operation. I beg to call attention more especially, to the stagnant water that is allowed to remain, and the state of the banks of the Cooum, the latter have much need of being more carefully looked after, and the common plan of the Natives making use of its bank and centre as necessaries, requires direct interference. I am aware that this has been attempted to be prevented by the building of temporary privies, but notwithstanding the vigilance of the Police authorities, it is still carried on to a considerable extent. The water found in this village is of the same bad quality as in Chintadrepettah, being only used for washing and bathing purposes, not even for culinary purposes; for the latter purpose I believe it is brought from some distance, viz., Nabob and Modeen gardens, and from the well belonging to the house occupied by Mr. Broomhall, a distance of a little less than a ¼ of a mile.

MACKAY'S GARDEN.—This native village is located on the side of the Cooum river, and which is frequently inundated by its overflowing, the people are generally of the lower order; there is only one good street running in a direction from west to east—from the main road to the bed of the river, throughout its whole length ahd breadth; with the above exception, the ventilation is bad, and the several ditches that intersect the place are made use of, for depositing the sweepings, &c., of the inhabitant's houses. The houses are of the worst description, low huts with mud walls not above 3 feet in height, which in rainy weather often tumble down—this village is supposed by many to be the nursery of cholera to a great extent, and may be the means of disseminating the disease even more than any of the other villages, on account of the inbabitants being servants of all the surrounding houses; to remedy the evil in my opinion the greater portion of this village should be annihilated, and a bund raised on the river side to a considerable height, to prevent the inundation. Streets should be made through the villages, and education should be introduced amongst them. The water is somewhat good and is used for all purposes, supplied from several wells; no drains are in existence, but only the ditches that I have already alluded to. I am informed that the Scavengers only visit this village about once a week

EGMORE.—I shall not offer any observations on this village, as what has been written above, will be sufficient to attract attention to its present indifferent state of cleanliness, and badly constructed drains. There is one ditch running between the northeast end of it, and the Male Asylum gate, that should be removed on account of its extremely dirty state. The Scavenger department visits the village daily. The water is in abundance and generally of a good quality. Public necessaries are much required, the system at present adopted by the Natives, from the want of them, is to resort to the bed of the Spur tank, in the vicinity, as well as the several paddy-fields on its north and west side.

NUNGUMBAUKUM consists of two villages—one, the larger and more populous of the two, is inhabited by caste people, Hindoos; the other, smaller, entirely by Pariahs—in the larger, improvement might be made in its cleanliness, though generally speaking it is far superior to any of the other villages of the district in that respect; the one occupied by the Pariahs is situated low, and surrounded by paddy-fields, and a ditch in front of the houses, that is not kept clean, it is thickly peopled, and in this place, cholera prevails to a very considerable extent; in fact, this place appears to me to be a nucleus, from which disease is generated, and from whence it is disseminated amongst many parts of this district; the water is good and plentiful and is supplied from wells that are in their own houses chiefly. The scavenger department is much needed, its visits being only once a week.

Having made some observations on the several villages in this district, and having pointed out, how very much deficient the system of drainage is in them all, as well as how inadequate the scavenger department is, for so many villages; having also pointed out the very obnoxious system that is now in full operation by that department, of eollecting all the rubbish that consists of both animal and vegetable matter, and when it is colleeted, that it is made use of to form roads, to fill up the many uneven plaees that are found in the centre, of the villages, and that it is a common enough system for the natives to build their huts on sueh a foundation, doubtless forgetting that all this matter of such a heterogeneous nature, must undergo decomposition, and does do so, emitting all the time an emanation that eannot be otherwise than of a most noxious quality: that slaughter houses are allowed to remain in the village of Chintadrepettah, that the supply of water is in abundance, though in several places such as Chintadrepettah, Comaleesapuren Covil, it is not of a good quality and is only used for purposes of washing, &c., and not for culinary; but that good water can be obtained from no great distance, and that authorities could at no great expense make use of the bad water for purposes of drainage, &c., also the necessity of intersecting the densely populated villages of the poorer Natives, by streets, and employing education (the ordinary village school system) amongst them, with the view of elevating them to a higher stage of existenee, and thereby teaching them the great benefit to be derived from personal cleanliness, more espeeially, I am fully aware, that to have all this done legislative measures must be sought for, in the shape of a municipal act, I would therefore call on the Medical Board to urge on the Government, that such should be granted, as not only the best means of elevating the lower orders of the people from a state of existence very little removed from the animal ereation, but as the best prevention of crime and disease of all kinds.

If they should be pleased to adopt a better system of drainage, I can see no difficulty in a larger supply of water being obtained by simply having public wells made in each of the villages, in number corresponding to the quantity of water required, and attached to them, large reservoirs in different parts of the villages, communicating with each other raised above the ordinary level of the village, this will ensure the water passing through all the several drains.

I would now beg to call attention to the district generally, and to point out how very defieient all the ditches are, that are now supposed to be kept in good order, also how luxuriantly the prickly-pear shrub is allowed to grow, thereby enabling the Natives to make use of it for purpose of sheltering him from the sight of the passers by, when he is called on to obey the calls of nature.

I am sorry to be obliged to dwell only on all those subjects in a general way, but as is too well known to the Medical Board, the absenee of all regis-

tration of Births and Deaths does not allow of me to be more minute on the influence that all such noxious agents have on the physical health of the inhabitants.

APPENDIX S.

MEMORANDUM ON THE HONORABLE COMPANY'S WATER·WORKS AT MADRAS, BY LIEUT. COL. A. T. COTTON, CHIEF ENGINEER, DATED JANUARY 22D, 1852.

With reference to the Memorandum by the Acting Secretary to the Military Board, respecting the water supply from the Seven Wells,

The Chief Engineer has the honor to observe that, in considering the cost of the water supplied from the Seven Wells to the Fort and to private individuals, it is necessary to take notice how much more valuable water is in a besieged Fort, than in a City in time of peace.

The Seven Wells and works connected with them were constructed for the supply of the Fort, more especially in time of war, and no expense seems to have been spared for the attainment of that object.

It has, in what follows, first considered the cost of the water delivered to Government and to private individuals, and next endeavoured to separate the expenditure on the raising of the water from that on the conveyance of it through the pipes.

The general results of this enquiry are

1st.—That the cost of the water to Government has been very great from the beginning.

2d.—That to private individuals, the cost is even greater than to Government.

3d.—That the current expenditure may be greatly diminished by the application of steam, in the place of the manual power now employed.

The Water Works were first commenced in 1772 by a Captain Baker, who come out from England for the purpose of executing them in accordance with the terms of the subjoined contract.

Captain Baker agreed to supply and keep always full reservoirs in the Fort, containing sufficient water for 6,000 men for 4 months, at the rate of 3 quarts per man, per day, for which he was to receive—

1st.—A free passage from England for himself and 3 Artificers.

2d.—He was allowed to bring out 150 tons of material, free of expense, to construct the necessary works with, and 10 tons annually to repair them with.

3d.—He was to receive 200 Pagodas monthly pay.

The contract was for seven years, after which it might either be renewed, or the Honorable East India Company might purchase the works from him.

The Works were purchased in 1782.

The account current of the Water Works has never been kept regularly, so that it is now scarcely possible to make out a complete one.

In order however to enable some idea to be formed of the actual cost of the works, the records in this office have been examined and an account prepared, which contains all the principal items.

From this account it appears that the Capital expended amounts to Rupees 4,11,668-10-0.

This Capital is made up of sums paid to Mr. Baker previous to the year 1782, (at which time he sold the works to the Honorable Company,) together with sums expended on the first construction of the works.

The current expenditure from 1782 to 1852 amounts to Rupees 4,30,272-8-3½.

It includes all current expenses except Interest on Capital.

The average annual cost of the Water Works since 1782 may be calculated as follows :—

Annual expenditure on Repairs, Establishment, &c. &c. $\frac{4,30,272\ \ 8\ \ 3\frac{1}{2}}{70 \text{ years.}}$	Rs.	6,146	12	0
Interest of Capital at 5 per cent. per annum	,,	21,513	10	0
Total average annual cost	Rs.	27,660	6	0

The quantity of water supplied daily varies no doubt, with the season of the year.

It averages at present 25,000 cubic feet, during the hottest season it is probably 45,000 cubic feet, this will give a daily average of 35,000 cubic feet taking the whole year round.

At this rate the yearly supply would be 12,775,000 cubic feet.

The cost of this has been shewn above to be Rupees 27,660-6-0, which gives the quantity of water supplied for each Rupee of Interest on Capital and current expenditure to be 461¼ cubic feet per Rupee.

Private individuals are allowed to purchase it, at the rate of 6 chatties a day for a subscription of 1 Rupee a month, the chatties contain on an average ⅚th of a cubic foot, taking the month therefore at 30 days, they receive for 1 Rupee only 150 cubic feet.

These figures show that private individuals pay too much for the water which they purchase from Government.

The following considerations however will shew still more clearly how unreasonable the charge is—

1st.—The cost of the water to Government includes all the expenses of constructing and repairing 76 Bombproof cisterns in the Fort, which are of use only in time of war or extreme scarcity.

The expenditure on the Water Works includes the three following important items.

1st.—Cost of raising the water.

2d.—Cost of conveying the water to Fort, Beach, &c., to an average distance of 1 mile.

3d—Cost of works executed for Military purposes.

The Capital expended on the works connected with the raising of the water, amounts to Rupees 20,613-8-1.

The Interest of this at 5 per cent. per annum, amounts to Rs. 10,080-10-8.

The average annual expenditure of the last 20 years on Establishment and Repairs, amounts to 3,323-11-6.

Total cost of raising 12,775,000 cubic feet of water, Rs. 13,404-6-2, which is at the rate of 952½ *cubic feet raised for one Rupee.*

The Capital expended on conveying the water to an average distance of 1 mile, Rupees 1,42,722-8-10.

The Interest of which at 5 per cent., Rupees 7,136-2-½.

The average annual expenditure on Repairs and Establishment under this head since 1800 is Rupees 1,804-11-7.

Total cost of conveying 12,775,000 cubic feet, Rupees 8,944-11-6, which gives the quantity conveyed 1 *mile for one Rupee to be* 1,428¼ *cubic feet.*

It will be observed that in dividing the cost of water into the above two parts, the expenditure on Establishment and Repairs has not been taken from the commencement, but only from 1800 and 1832, this was owing to the confused state of the accounts in the previous years.

In raising the water from the wells into the cisterns, 31 pecottah men are employed, at 7 Rupees a month each.

Their pay for one year amounts to Rupees 2,604, for which sum they raise 12,775,000 cubic feet or 4,900 cubic feet for 1 Rupee; this amount could be raised by steam at Madras for 4 Annas 6 Pice.

The annual supply of 12,775,000 cubic feet would be raised by a 5-horse power steam engine for Rupees 854-7-3. Thus causing a saving of Rupees 1,749-8-9 per annum.

This saving is clear as the cost by the engine includes interest on Capital and all current expenditure. The work would be done still better, and for very nearly the same cost by two engines, one a 4-horse and the other a horse power—the former would be employed in raising all the water to the level of the lower cisterns, and the latter would raise the supply for the first into a reservoir on a higher level than the cisterns as the pecottah men now do.

ABSTRACT No. 1.

DISBURSEMENTS.

		Rs.	A.	P.	Rs.	A.	P.
1. Money paid for purchasing the works from Captain Baker in 1782 ... Pagodas	30,000						
Money paid salary 200 Pags. a month for 10 years „	24,000						
		1,89,000	0	0			
2. Allowed freight of 150 tons ... Rupees	3,000						
Passage money for Capt. Baker and 3 Artificers. „	2,500						
		5,500	0	0			
3. Cost of Cisterns on the south side of the Fort square and on the sea line ...		66,702	9	1			
4. Average cost for 5 Cisterns built at Convict Jail, Grand Jail, 2 Schools near Flag Staff and Mint Bastion ...		3,500	0	0			
5 Charges for new works and improvements, sinking several wells, constructing Bungalows, Cisterns, Out-Houses, Compound walls, communicating leaden Iron pipes and several other works.		1,30,798	15	7			
6. Price of the Land ...		16,167	1	4			
Total of Original Cost Rupees ...					4,11,668	10	0

ABSTRACT OF CAPITAL EXPENDED.

Amount expended for raising water ...		2,02,243	8	1
Do. do. for conveying do. ...		1,42,722	8	10
Do. do. for building Cisterns for Military purposes ...		66,702	9	1
	Rupees ...	4,11,668	10	0

	Rs.	A.	P.	Rs.	A.	P.
7. Charges for the expenses of Water Works from July 1787 to April 1800 ...	94,087	8	10			
8. Charges made for the expenses of the Water Works ...	2,226	5	5			
9. Do. do. for Articles purchased ...	6,706	6	10			
10. Do. do. for repairing several works of the Water Works...	44,196	4	3			
11. Servants' wages from May 1800 to November 1852 ...	2,70,740	10	10			
12. Contingent Charges ...	5,880	7	11½			
13. Extra Establishment ...	9,224	7	0			
14. Peons' Clothing ...	588	0	0			
15. Rice Compensation ...	122	5	2			
				4,33,772	8	3½
Deduct average cost for 5 Cisterns ...				3,500	0	0
Total of Current expenditure, Rupees ...				4,30,272	8	3½

ABSTRACT OF CURRENT EXPENDITURE.

Amount expended for raising water ...		3,36,371	12	10½
Do. for conveying do. on repairs ...		3,653	13	2
Do. probable amount of Servants' wages...		90,246	14	3
	Rupees ...	4,30,272	8	3½

Grand Total of raising, conveying, building Cisterns for Military purposes, and Servant wages, &c. ...	8,41,941	2	3½

CHIEF ENGINEER'S OFFICE,
FORT ST. GEORGE,
22d *January* 1853.

A. T. COTTON, Lieut.-Colonel,
Chief Engineer.

ABSTRACT No. 2.

No. 1.

CONVEYANCE OF WATER.

Capital expended	92,722 8 10		
Add probable amount expended on piping by Captain Baker	50,000 0 0		
			1,42,722 8 10
Repairs of work for 50 years, viz., from 1802 to 1852, Rups. 3,653-13-2—for a year Rupees		73 1 2½	
Establishment for 52 years, viz., from 1800 to 1852, Rups. 90,246-14-3—for a year Rupees		1,735 8 3	
Total for a year, Rupees		1,808 9 5½	
Interest on Capital at 5 per cent. per annum		7,136 2 0½	

Total cost of conveying 12,775,000 cubic feet to an average distance of 1 mile. . Rupees 8,944 11 6 which is at the rate of 1,428¼ cubic feet conveyed to an average distance of one mile for 1 Rupee.

This abstract has been made out in the following manner.

The Capital has been found by adding together all the items in the account current which were for conveying the water to which was added Rupees 50,000 assumed as the value of piping laid down by Captain Baker, there being no account shewing its actual quantity or value.

The Abstract itself shews how the average expenditure on Repairs was found.

The cost of the Establishment connected with the conveyance of the water having always been ⅓d (or a little more or less) of the cost of the whole Establishment, that proportion has been taken; the cost of whole Establishment for 52 years is Rupees 2,70,740-10-10.

No. 2.

RAISING OF WATER.

Capital expended on the Works	2,02,243 8 1	2,02,243 8 1
Interest on the above at 5 per cent per annum	10,080 10 8	
Average annual expenditure for the last 20 years	3,323 11 6	

Total cost for raising 12,775,000 cubic feet 13,404 6 2 which is at the rate of 952½ cubic feet raised to an average height of 20 feet for 1 Rupee.

No. 3.

Cisterns built for Military purposes	66,702 9 1
Total Rupees	4,11,668 10 0

MEMO. OF THE CAPITAL EXPENDED.

Amount for conveying water	1,42,722 8 10
Do. for raising water	2,02,243 8 1
Cisterns built for Military purposes	66,702 9 1
Rupees	4,11,668 10 0

This Abstract has been found in the following manner.

The Capital has been found by adding together all the items in the account current necessary for the raising of the water including Bungalows, &c. &c.

The average annual expenditure has been found as follows:—

Cost of the Establishment from 1832 to 1852	87,863 3 7	
Do. of Repairs since 1832	8,814 2 1	
Total expenditure in 20 years		96,677 5 8
Average annual current expenditure Rupees 4,854-11-3 of which for conveying the water	1,521 15 9	
Do. do. do. do. for raising the water	3,323 11 6	
		4,845 11 3
Pay for the Establishment for the conveyance of the water from 1832 to 1852	29,363 15 8	
Repairs of work connected with do. from 1832 to 1852	1,076 12 1	
Total for 20 years		30,439 11 9
Average for 1 year	1,521 15 9	
Remaining average annual expenditure on Establishment and Repairs for raising the water	3,323 11 6	
Rupees		4,845 11 3

CHIEF ENGINEER'S OFFICE, Fort St. George, *22d January* 1853.

A. T. COTTON, Lieut.-Colonel, *Chief Engineer*

APPENDIX T.

MEMORANDUM BY LIEUT.-COLONEL A. T. COTTON, CHIEF ENGINEER AND MEMBER, MILITARY BOARD, IN CONTINUATION OF NO. 278, DATED 31st AUGUST 1852. (See Appendix A.)

I have in a former paper stated my views in favour of this project, but I think it may be well here to endeavour to answer such objections, as I have heard of stated against it; and which may perhaps be thus summed up—

1st.—That there is no necessity for any works on sanitary grounds, on account of the healthiness of Madras.

2nd.—That the money could be expended with greater results up the country.

3rd.—That Madras has already had a great deal of money spent upon it.

4th.—That it wants a Pier, more than water and water carriage.

2. In answer to the first, I remark that the proposal to spend money on Madras did not originate with me; the Honorable Court had actually sanctioned an expenditure of 73,000 Rupees on a mere patch-work attempt to improve the sanitary state of Madras, and the Justices as I believe, had fully made up their minds to spend a further sum of 50,000 Rupees in throwing salt water into Black Town; that point therefore was settled. Questions connected with the expenditure already ordered by the Court were placed before me upon which I was obliged to come to some decision; and nothing could be clearer to my mind, upon investigating the matter, than that before another Lack was spent in addition to those already laid out on various petty works, the fundamental point, the bringing fresh water into Madras, should be considered. That very large sums have been spent in detached improvements, that large sums were sanctioned for others, and that further very large sums were sure to be spent, seems to me to confine the question to *what* should be done, and I therefore did not enter upon that of the expediency of doing something. And the examination of the subject at once made it evident to me that what was most obviously the fundamental measure as respects the sanitary improvement of Madras, was equally a fundamental one for the other wants of the city.

3. If however I am called upon to answer the question whether it is advisable to spend large sums of money on Madras or not, there seems to me no possible room for doubt on the point. In using the term "sanitary," I did not mean to exclude the points of comfort and convenience, and to consider only the sickness and mortality: it is impossible in fact to prevent the latter, without attending to the former. That Madras is not a particularly unhealthy

city but rather the contrary, is notorious, but it is not the least less certain that it might be much more healthy than it is. The fact is indisputable that ninety-nine hundredths of its population live in an atmosphere tainted to a great degree. To a person not compelled to live habitually in the streets and thickly populated parts, the smell there is so intolerable that it seems impossible to remain in it, and incomprehensible that the place should be at all healthy. If the Europeans, East Indians, and Natives, who live in the atmosphere of the drains are asked whether they think this a matter of little consequence, it will be easily ascertained that the opinions of those who live in this tainted air is very different from that of those who live out of it. Though the city is not comparatively speaking an unhealthy one, yet we know well that vile smells are an unmistakeable indication of something injurious to health; they are obviously intended, not needlessly to distress us, but to give us warning of serious evil; and that which would diminish them would materially promote health. The fact is undeniable that notwithstanding the care now taken to cleanse the city and with a most active system of management, every part of the thickly populated parts of the place are loaded with disgusting and destructive effluvia. Though Madras is not one united dense city, yet it is composed of a collection of dense towns, each containing from 30,000 to 100,000 inhabitants, and those as closely packed together as they could well be, allowing for the houses being only of one story.

4. Is there the shadow of a doubt that if this polluted air were purified, sickness and death would be to a most important degree diminished? Suppose 1 in 10 to be either actually sick, or in worse health than they might be if the air were greatly freed from these abominable effluvia, and that by cleansing the place this number were reduced one-half, a very reasonable supposition, then 35,000 persons would be materially benefitted in their health by cleansing the city and the mortality would be reduced in the *same degree.* Is this a small matter? Ask the sick themselves, and the families that are burthened each with a member who cannot earn his own livelihood, and the importance of this point will be better understood. If a medical man should be the means of restoring 200 or 300 persons to health or of saving the lives of fifty in a year it would be thought much, but attention to the sanitary condition of the place will undoubtedly do more than a hundred doctors. Why do the Government go to a great expense in supporting dispensaries and medical attendants? Because they rightly judge that it is the duty of a merciful and considerate Government; and I have no doubt that the sums so expended are the interest of a sum that would do far more to the attainment of this object if it were expended on preventive means. The late investigations at home leave no doubt whatever on any man's mind who reads the works lately published on such matters, that the expense of prevention is far less than that

of cure. The point I therefore insist upon is this, that the question is not; Shall we spend money to promote the health and comfort of the three-quarter million who inhabit Madras? the acts of the Government have decided this question; we have spent, are daily spending, and are about to spend large sums for this purpose? The question is confined to this point—*How* can the money be most effectively laid out? And I am convinced that the more the subject is investigated the more clear the conclusion will be, that the first and fundamental thing is to throw into it an abundance of good water. Among the many publications that may be consulted on this subject, I may refer to the 2d Report of the Commissioners of Enquiry into the sanitary state of towns in England. A few quotations from that valuable document, will be added in an appendix.

5. For these reasons I perfectly agree with almost all who have had to deal with this question, that the cleansing of Madras is most urgently required, and that there is scarcely any thing more desirable at this moment, than to supply its 700,000 inhabitants (a population exceeding that of some Collectorates) with fresh water.

6. For the 2d objection, (viz., that the money could be expended with greater results up the country) I must say that I am confident an examination of the matter will bring us to a different conclusion. A compressed population labour under many disadvantages, but on the other hand they have many advantages, one of which is that from their concentration, in general a far greater extent of benefit can be obtained at a certain cost than when they are more scattered. The sum of money that would supply water for domestic purposes, cleansing, irrigation, and navigation, for a population of 700,000 concentrated in a space of nine miles by three, would not do the same for a fifth part of that number if spread over a space of 100 miles by 50, and this is the reason why all over the world such large sums are spent upon cities. The question is not whether there is one place or twenty to be benefitted by a certain expenditure, but rather what the numbers are which will be benefitted. To bring an abundant supply of fresh water to every man's door, where a population is scattered through towns and villages, would cost far more than where the same is collected in one place. And so also with respect to irrigation; how plain it is that if it is worth while to irrigate land in the interior, much more must it be profitable to irrigate the land within the precincts of Madras, where the land and the produce are so much more valuable. If a man who owned land in Madras, and also in a distant village, were asked which he would rather have irrigated, we know well what his answer would be. The proof of the value of irrigation in Madras is shewn by the fact that thousands of wells are now worked for irrigation at a cost of one Rupee per 300 cubic

yards of bad water, while good water could be supplied from tanks at a tenth-part of that cost. The irrigation of land within Madras compared with that at a distance is in fact the difference of irrigating kitchen garden land and farms.

7. The same also with the navigation; the question is, where would a few miles of canal be most extensively beneficial, amidst a population of a few thousand, or of a few hundred thousand? And here is a substitution of an inexpensive carriage for one which at this moment causes a much heavier expenditure. There is at this time an annual outlay of several thousand Rupees a year on the side roads of Madras, a large portion of which would be saved, if there were water communication through the place. The present plan provides for a navigation of about 18 miles from Clive's battery to Palaveram; the conveyance of an average of 100 tons of goods a day on this line would cost about 10,000 Rupees at 3 Pie per ton per mile; the same quantity carried by land would cost 60,000 Rupees; and the saving, 50,000 Rupees a year, is the Interest of 10 Lacks. And there can be no doubt that a most extensive passenger traffic would be soon carried on, on such a line; one of the great drawbacks to Madras being the distance that such multitudes have to traverse every day on account of its extraordinary extent.

8. And if, as it seems to me most evident, in each of these ways money expended on such a scheme as this would produce far greater results than when expended up the country, how much more when they are all combined, and each has to bear only a portion of the cost of the works. I believe if this is well considered, any person may be satisfied that in no other place could so large a population be so extensively benefitted in so many ways, and consequently no where could a larger return in money be obtained, if it were deemed expedient to obtain a direct return in money. The money already ordered to be expended was not intended to produce any money returns, and that contemplated to be spent by the Justices would be a portion of the funds at present collected from householders. But why should one Rupee be demanded from any body for such a work as this. In England there would not be a moment's question about funds in such a case. The Interest of the money would be a mere trifle compared with the benefit obtained, and if the Interest be provided for, the Capital must necessarily be forthcoming. The sum proposed to be expended at present is 3 Lacks, the Interest at the utmost 18,000 Rupees a year, (6 per cent;) an average house tax of 2 Annas a year would meet this; the irrigation of 3000 acres at 6 Rupees a year would cover it; a toll of 5½ Pice a ton per mile on the navigation (probably much less) would provide it; any one of those three means would be alone sufficient, supposing that neither Government nor the present Assessment fund paid anything. To call upon the present

generation to pay the Capital for such works appears to me clearly unjust, as well as impolitic. Let all who receive benefit pay their share of the cost, in the shape of Interest as is invariably done in England in such cases. No possible object can be gained in delaying such improvements as the health and comfort of 700,000 persons demand, when they can afford to pay the Interest money twice over; nothing whatever is gained by waiting till either the Government or the people can afford to pay down the Capital. If such a system had been followed in England there would not have been to this day, a single city properly lighted, cleansed or watered.

9. If the annual sum laid out on improvements from the Assessment fund were paid as Interest, there would be at once a sum disposable which would do in a year or two what this vast community may otherwise want for twenty or fifty years upon the present system. It is one of the most extraordinary facts connected with India that this most obvious principle so perfectly understood, acknowledged and acted upon by every man in England, should as it were have been swept from the minds of our countrymen as soon as they had any thing to do with India. In this as in every other case the plea has been that there is no money to execute works which would produce ten times the Interest of the sums required. The degree in which the welfare of India has been hindered by this strange mistake is far beyond all calculation. In the present case nothing can be simpler or more obvious than the course that might be pursued. If money be the difficulty, it is only to pass an act permitting the municipal authorities of Madras or the Government to raise money by loan, undertaking to pay the Interest: and I suppose without one additional Rupee of Capital being paid by either the inhabitants or the Government, there would be abundant funds not only for the present works, but also to wipe off that standing disgrace to the Port, that there is neither shelter for shipping, nor safe and convenient means of landing passengers and cargo. Let the Government engage to pay 25,000 Rupees a year and the Justices a like sum from the Assessment fund, (I suppose much less than they both actually now spend in improvements and various current expenditures that would be relieved by works such as are now proposed) and there would be available about 10 Lacks of Rupees, sufficient to do at least half, if not all that Madras at present requires; and these works would, if thought advisable yield such a return in money as would provide for further improvements far beyond what there is any probability of the place requiring. The cleansing, lighting, communications, and Port improvements might all be carried out without the slightest difficulty as respects money.

10. The question therefore as respects the improvement of Madras rather than an inland district, is not properly—why lay out so much money on Madras, while Cuddapah is without roads? but rather what possible reason can

there be for depriving the immense population of Madras of the advantages which it can so easily afford, merely because another locality is without some advantages which it needs, we might equally well argue, why do any thing for India while Africa is in such a savage state ?

The simple fact is that both Government and the municipal authorities have been and still are spending more money annually in patch-work with trifling effect, than would be sufficient to carry out an extensive and well planned system of works that would accomplish all the ends that are desired.

We have an undeniable proof how abundantly remunerative Capital may be here, by the results of Cochrane's Canal which now yields 30,000 Rupees a year, the Interest of 6 Lacks, while such a work would be executed for a twentieth part of that sum.

11. With respect to the 3d objection (that Madras has already had large sums spent upon it) I answer, 1st.—It certainly has, and the consequence is, (as is usual) that it has now become of such value, that it is worth taking care of and improving. When you have collected such a mass of people into one place, it is only so much the more necessary and remunerative to take care of them.

12. And 2d.—That so much money has been laid out so advantageously although in so injudicious a manner, is the very thing that should encourage us to lay out the money in future on a more comprehensive plan, in the assurance that the results will be proportionably so much greater. All that has yet been done may be properly described, as a patch by the Justices here, and another by the Government there, without any reference whatever to a comprehensive plan, and the waste of money has consequently been immense. The most distinct proof of the mistaken system that has been followed is in the case of the Bulwark. For this work 150,000 tons of stone were brought from the Mount and Palaveram, at about 3¾ Rupees per ton for carriage alone, or 5,60,000 Rupees in all. If a line of canal had been made from Palaveram to the north beach, this might have been conveyed to the spot by an average of 15 miles of water and ½ mile of land carriage, at a cost of ½ Rupee a ton, or 75,000 Rupees in all, and if a Lack of Rupees be allowed for completing the line of canal, there would have been a total expenditure of 1,75,000 Rupees, instead of 5,60,000 or a saving of 3,95,000 Rupees, on that one work, besides giving Madras the benefit of 18 miles of water communication, connected with Cochrane's canal, worth at least 50,000 Rupees a year, or in all since the construction of the bulwark in 1822, 15 Lacks of Rupees. But who can calculate what might have been done for Madras in this interval, if the granite quarries at the Mount had thus been made available for the Port at so trifling a rate per ton ?

Such a misapplication of money will certainly continue, if each of the wants of Madras is still to be attended to as an insolated thing, and by a distinct department.

13. We come to the 4th objection; viz., that Madras wants a Pier more than water.

First, it is surely at least a fair question, whether the health of the people is not of as much consequence as a Pier? I suppose I may be allowed to take it for granted that healthy as Madras is, much sickness and mortality would be prevented if it were freed from its loads of effluvia.

14. Secondly, to say that Madras wants a Pier is rather begging the question; it wants some works to improve the Port, both to facilitate landing and to protect shipping, but what those works should be is a proper matter for consideration. I am myself fully persuaded that a Pier would be but a very imperfect means for facilitating the landing, and that shelter from the swell is absolutely necessary to the accomplishment of this end: I most fully concur with those who hold that the providing of means of safe and convenient landing at Madras is one of the very first things required; and that we should have been here more than a hundred years without having made one attempt to effect it, is one of the most disgraceful things to us that I know of. The commencement of the Break-water can scarcely be called an attempt, because it was never carried out so as to show its effect. When the Guano Island of Ichaboe was discovered on the coast of Africa, hundreds of ships resorted to it, and as even on the lee side there was a heavy surf, they immediately as a matter of course, without an Engineer or even a Government, constructed no less than 36 temporary Piers out of ships' spars, and dropped the cargoes into boats from the ends of them at the back of the surf. This was done entirely by the officers of the ships without the least experience in such work, and at a cost of a few pounds for each, including the injury done to the spars, while here we have been seated in front of a surf for a hundred years, with the Government and a large commercial community on the spot, having before our eyes the inconvenience and danger to passengers, and bearing a loss in the cost of shipping and landing cargo which would have paid for the most complete works a hundred times over.

15. The Piers formed at Ichaboe were of course an imperfect means and were liable to be destroyed; the ends were exposed to the swell of the sea so that it was still rough work to embark and disembark cargo and passengers, but still it was an immense improvement, and shows clearly how much even an insignificant work could do to improve the landing. But the essential thing is a short break-water to keep off the swell, and such a work must be executed before long. A ship break-water should however never be

lost sight of. Such a work in 7 fathoms would require about 1,000 tons per yard of length, or 2 millions tons for 2,000 yards, and if the canal were executed from Palaveram to the northern beach and the small break-water were built to facilitate the loading of the boats, the stone could be deposited at ½ Rupee a ton, and the whole executed for 10 Lacks. The real state of the case therefore is this, that one of the important ends to be gained by the works now proposed is that we thus lay the necessary foundation not only for sanitary improvement but also for that of the Port. Thus this objection is in fact one of the strongest arguments that could be advanced for the construction of a tank and canal. Considerable sums have been spent of late years in protecting the coast by means of stone groins, and there will certainly be a constant demand for stone on this account also in future.

16. Another essential thing for the improvement of the Port is the obtaining a greater space in front of the Custom House and commercial buildings, and this can easily be done by forming groins, (as indeed has been commenced at the Custom House,) so as to collect the sand and extend the bank further to seaward. At Vizagapatam the line of the beach has been permanently removed 70 yards to seaward by these means. And for this also stone will be required.

I trust the objections are thus most fully and conclusively answered. There is no place in the Presidency where more extensive good could be effected for a certain sum than in Madras itself, and no place where the money advantages would be greater. And I believe there is not a point in the physical improvement of Madras, for the promotion of which, a reservoir of water with a navigable canal from the Mount to the beach, would not be a fundamental work.

17. The advantages in money that would be derived from it are these

1st.—The present expenditure on cleansing roads, conveyance of stone for Government works, on dispensaries, on additions and alterations to the tunnel &c., would be diminished.

2d.—A large sum would be saved in the transport of goods and materials in Madras, probably at least 50,000 Rupees a year; part of which might be taken in tolls if thought desirable.

3d.—Probably 10,000 acres of land might be irrigated, half of it throughout the year as garden and rice land, and half as grass land in the compounds. The actual value of water so applied would be immense, at least ten Rupees an acre on an average, and of this ½ or ⅓d might be taken as water rent if necessary, yielding from 30,000 to 50,000 Rupees. Of the great

value of this a judgment may be formed, from the ease of the Horticultural garden an extent of only a few acres, which is only partially watered from a well of bad water, at a cost of 300 Rupees a year. It could be supplied with a profusion of good water from the proposed works for 20 or 30 Rupees a year, and leave an abundant profit for the works out of that.

4th.—A great saving would be effected in the procuring water for domestic purposes, and of course a water-rate might be levied if considered advisable.

5th.—An immense saving of money might be effected by passenger traffic on the canal. At present there are about 100 passengers a day on Cochrane's canal, only between Madras and Pulicat, though it leads to nothing beyond, and though the speed is slower than the rate at which a man walks, and about 15 Rupees a day are paid by the passengers. Considering this and the enormous passenger traffic on the roads in Madras, small steamers with a speed of 6 or 8 miles an hour might ply on the canal probably every ¼ hour, and convey multitudes of passengers. Perhaps there is no place in the world (excepting London and other first class cities) where there is so much required or where there is so large a population collected, and yet spread over so considerable a space.

6th.—It would greatly add to the returns of Cochrane's canal; if the firewood, &c., brought by that line could instead of being stopped as at present at the northern extremity of the city, four miles from the centre, could be brought and landed at all points through the heart of the place, this would greatly increase the present traffic, which now yields 30,000 Rupees a year.

When these things are considered, there can be no sort of question about the enormous returns in money that would be derived from those works to the Government and the inhabitants, nor about the direct revenue that could be derived in tolls, and water-rates, if it is required to raise a direct revenue. And consequently there can be no question about providing the Interest for any sum of money that can be necessary for the improvement of Madras in every way.

18. Since my first Memo. on this subject was written, some rough levels have been taken up the valley of the Adyar, from which it appears that there is a most remarkable basin just above Palaveram, which once formed the bed of a magnificent tank, that must have been from 12 to 20 miles in circumference, perhaps more. There is something very remarkable in this feature. I have never seen a similar perfect basin or lagoon, nor heard of one, in the Peninsula before. There appears to be no rise whatever in the valley for five or six miles. The bund of this tank is still in existence, though with two or three breaches in it, and could be perfectly restored for 10,000 Rupees. There is now a very large area probably 10 square miles, without a house or a tree on it, but the tradition among the people is that 23 of the surrounding villages also stand on

ground that was within the bed of the tank. Were it not for these villages an immense tank might be formed, but even without raising the water so high as to cover any village, we might have a large reservoir. But further, the bed of the Adyar in the breach of this bund is only about 30 feet above the mean level of the sea, so that a bund of that height at the head of tide water, viz., at the bed of the Adyar nearest the long tank, would throw the water back to the old tank, and a few feet more would make it stand back to the head of the basin which it occupied, a distance of 15 or 16 miles. This is a most remarkable fact when it is considered that the general rise of the country from the coast is 6 or 8 feet a mile. In this respect I have never seen any site for a tank to be compared with this, it might be supposed to have been provided for the very purpose of supplying Madras with water. The chief expense would be the compensation for cultivated land that would be flooded. Probably the best way would be to repair the old bund so as to retain only a moderate depth of water in it, and to make a second bund either at the Mount or between that and Marmalong bridge, of such a height as to retain the water to as great a height as the Cantonment of Palaveram would allow, the Parade ground of which is about 40 feet above the mean level of the sea. I should however mention that these levels have not yet been checked, though I believe there is no considerable error in them. How very slight the rise of the country is on the line of the Adyar will be understood from the fact that the bed of that river at the head of the old tank about 7 miles above Palaveram is not 30 feet above the top of the bund of the long tank, 19 miles distant. If ten feet depth of water were retained in the old tank, it would only require about 4 locks of 10 feet rise each, to form the navigation from tide water, making a water communication of 25 miles from Clive's battery.

19. I append a rough estimate to give some idea of the value and returns of the different uses to which the water may be applied, independently of its sanitary effects.

Estimate of cost, value and charge for water in Madras.

	Quantity in millions of cubic yds. of water.	Cost in Capital Rupees.	Interest at 6 per cent. or annual cost.	Value each year.	Proposed charge ¼ value.
Consumption for 700,000 people, at 2 cubic feet or $\frac{1}{13}$ cubic yards per day each for one year.........	20	60,000	3,600	90,000	22,500
Irrigation of 4000 acres at ¼ inch of water per day for 280 days or 3000 acres actually watered.	40	90,000	5,400	40,000	10,000
Irrigation of 4000 acres partially watered for grass at $\frac{1}{10}$ inch...	16	48,000	2,880	16,000	4,000
Evaporation of tank, average 8 square miles, a depth of $1\frac{2}{3}$ yards allowing for rain.........	40	....	....	....	....
Water Power, equal to that of 300 pair of bullocks, half of which to be consumed, the rest being used for the above purposes..................................	15	45,000	2,700	36,000	9,000
Navigation lockage, 20 locks fall per day..............................	1	3,000	180	50,000	12,500
Total..	132	2,46,000	14,785	2,32,000	60,000

Supposing the tank to be kept supplied for 4 months in the year, its contents must be $\frac{8}{12}$ of the above or 85 millions; at 3 Rupees per 1000 cubic yards, it would cost $2\frac{1}{2}$ Lacks.

Saving in wear of roads.. Rs. 5,000
Passenger traffic, 1000 per day over 20 miles at ½ pice per man per mile.. Rs. 18,000

83,000
Deducting for Repairs, &c., Rs. 23,000

Net Annual Income, Rs. 60,000

Which at 6 per cent is the interest of.................................10 Lacks.
Estimated cost of works, tank, &c., $2\frac{1}{2}$ Lacks.......................
Navigation.............................. 1 ,, ... } $3\frac{1}{2}$,,

$6\frac{1}{2}$ Lacks.

Leaving $6\frac{1}{2}$ Lacks for iron pipes and various improvements of many kinds; besides the gain of 1,70,000 Rupees per annum, the difference between the charge and the actual value of the several advantages.

20. In explanation of the foregoing estimate I append the following remarks.

The value of the water for domestic purposes is here estimated at 2 Annas per head, or 10 Annas per house per annum, and it is proposed to be charged at 2½ Annas per house.

The irrigation throughout the year is reckoned to be worth 10 Rupees per acre for two or three crops of grain &c., or one of sugar, and the charge proposed is 2½ Rupees per acre; a great deal is already irrigated for part of the year; this charge would therefore be in addition to the present land tax.

The irrigation of the grass lands is estimated to be worth 4 Rupees an acre and the charge proposed is 1 Rupee.

The Water Power is reckoned at the rate of 10 Rupees a month for a pair of bullocks, and 2½ Rupees is proposed to be charged.

Half of the water so used is assumed to be afterwards used for irrigation, &c., and the other half, from its being applied in low situation &c., to run to waste.

No water is *consumed* in the evaporation from the Cooum, because that will be much more than supplied by the waste water.

The navigation would extend from Clive's battery to 9 miles above Palaveram in all 27 miles. The value is calculated by allowing 100 tons a day on an average to pass along 20 miles, and that 1¼ Annas per ton per mile is saved by conveying by water instead of by land.

The passenger traffic would be enormous, it is reckoned at an average of 1000 a day over 20 miles, and the charge is ½ Pice per man per mile, or for instance 3 Pice from the Cathedral to Cochrane's canal basin; probably the charge for conveyance would be about the same, making a total charge of 6 Pice for that distance.

21. To show the large amount of traffic carried on upon the line in question even under present circumstances, I had a table of that passing Palaveram on the Madras and Chingleput road, the goods conveyed consist chiefly of firewood, straw and other consumable articles for the supply of Madras, brought from the direction of Chingleput, part of which would necessarily be carried by this line of navigation.

The traffic as taken on the 22d of February of this year was as follows :—

Passenger bandies	68
Goods do.	1,534
Bullocks	268
Foot travellers	2,960

This vast traffic on an imperfect common road, without means for continuous transit, so that both goods and travellers must proceed by daily stages of from 15 to 25 miles, shows how enormous it would be if the cost and time were reduced to $\frac{1}{10}$th, as it would be by a steam canal. Leaving out 65 days of the year for diminished traffic during the monsoon, the cost of this traffic may be thus calculated;

1000 loaded bandies	× 300 at 1 Anna	Rs.	18,750
68 passenger bandies	× 300 at $1\frac{1}{2}$ Anna	„	1,275
150 loaded bullocks	× 300 at 2 Pice	„	470
3000 foot passengers	× 300 at $1\frac{1}{2}$ Pice	„	6,800
	Total cost per mile per annum...	Rs.	27,295

In this estimate I allow for less than $\frac{2}{3}$d of the bandies being loaded. I calculate the expense of the foot travellers at $1\frac{1}{2}$ Pice a mile, or $2\frac{1}{2}$ Annas a day as the average value of their time, supposing they walk 20 miles a day. We have thus the extraordinary sum of 27,000 Rs. a year spent in traffic on every mile of this road, and hence if a canal could be worked at 2 Pice a ton per mile, or $\frac{4}{5}$th Pice per bandy load, $\frac{1}{15}$th of the cost by an imperfect road, (of which there can be no doubt from the rate of 3 Pice on Cochrane's canal in its present imperfect state,) there would be a saving of 25,000 Rupees a mile, or on the 20 miles from the head of the Palaveram basin to the centre of Madras 5 Lacks a year, the Interest at 10 per cent. of 50 Lacks. This will give some idea of the enormous waste of money in Madras and its neighbourhood from want of cheap means of transit. If there are 3000 foot travellers a day 11 miles from Madras, what must there be in Madras itself? and what would there be if instead of walking at 3 miles an hour and at a cost of $1\frac{1}{2}$ Pice a mile, they could be conveyed in steamers at $\frac{1}{2}$ Pice a mile, and at 8 miles an hour.

APPENDIX U.

MEMORANDUM ON THE ADYAR BASIN, BY LIEUTENANT COLONEL A. T. COTTON, CHIEF ENGINEER, DATED MADRAS, APRIL 22D, 1852.

The basin of the Adyar extends in a S. W. direction inland from St. Thomé, the S. W. extremity being about 25 miles from that village.

Its breadth gradually increases from $1\frac{1}{2}$ miles where the southern coast road crosses it to about 6 miles near Peerungallatoor, which is $15\frac{1}{2}$ miles in a direct line from St. Thomé—immediately after this it increases more rapidly up to 21 miles at the south western extremity of the basin.

The total area of the basin is 216 square miles, of which there are below the bund of the old tank proposed to be restored, 38 square miles; and above it 178 square miles; but in this area there are 61 tanks having water-spreads of various sizes from 20 acres or $\frac{1}{32}$ of a square mile to 600 acres or $\frac{15}{16}$ of a square mile.

The aggregate area of the water-spreads of all these tanks is about $13\frac{1}{2}$ square miles.

Their mean depth is probably about 4 feet and their aggregate contents $=\frac{4}{3}\times13\frac{1}{2}\times3{,}097{,}600=56$ millions cubic yards.

The contents of the proposed new reservoirs will be about as follows:—

	Square Miles.	Millions Cubic yards.
Old tank restored..	$7\frac{1}{2}$ by 3,097,600 by $\frac{4}{3}$ =	31
New tank below the present one..................	$2\frac{1}{2}$ by 3,097,600 by 2 =	$15\frac{1}{2}$
	Total......	$46\frac{1}{2}$

From a rain table which has been calculated in this office by omitting the first half inch of every fall in order to allow for absorption, it appears that the mean water supply of that portion of the basin which is situated above the old tank has been on an average of 49 years, from 1803 to 1852 as follows:—

The area of this portion of the basin being 178 square miles.

		Millions Cubic yards.
The quantity in May has been	178 by 3,097,600 by $\frac{2.095}{36.}$ =	32
,, ,, ,, June ,, ,,	178 by 3,097,600 by $\frac{.812}{36.}$ =	$12\frac{1}{2}$
,, ,, ,, July ,, ,,	178 by 3,097,600 by $\frac{2.084}{36.}$ =	32
,, ,, ,, Aug. ,, ,,	178 by 3,097,600 by $\frac{3.129}{36.}$ =	48
,, ,, ,, Sept. ,, ,,	178 by 3,097,600 by $\frac{3.416}{36.}$ =	52
,, ,, ,, Oct. ,, ,,	178 by 3,097,600 by $\frac{9.383}{36.}$ =	$143\frac{1}{2}$
,, ,, ,, Nov. ,, ,,	178 by 3,097,600 by $\frac{11.956}{36.}$ =	183
,, ,, ,, Dec. ,, ,,	178 by 3,097,600 by $\frac{4.233}{36.}$ =	$64\frac{1}{2}$
,, ,, ,, Jan. ,, ,,	178 by 3,097,600 by $\frac{.694}{36.}$ =	$10\frac{1}{2}$
		Total...578

The contents of all the reservoirs, those now existing and those proposed, being 102 millions cubic yards—we may judge from the foregoing calculation

together with that which follows, that the supply would be received as follows; the evaporation from the surface of the tank is taken at an average of 13 years.

	Received.	Expended.		Total Expenditure.	Remaining in tanks.
		On evaporation	usefully.		
	Million cubic yards.	Million cubic yards.	Million cubic yards.	Million cubic yards.	Million cubic yards.
In May.........	32	14	14	28	4
,, June	12	14	2	16	0
,, July........	32	12	20	32	0
,, August. ...	48	18	20	38	10
,, September.	52	15	20	35	27
,, October. ...	14	17	25	42	129
,, November.	183	15	25	40	tank surplusing.
,, December..	65	16	25	41	Do.
,, January ...	10	20	25	45	67
,, February. .	none	15	15	30	37
,, March......	none	10	15	25	12
,, April.... ...	6	5	13	18	0
		171	219	390	

From these two tables it appears that in an average year—

That in the months of September, October and November, water would be flowing over the calingulahs and out to sea by the Adyar; and that the quantity thus run out would be=579—219= 360 million cubic yards.

The basin appears to be generally rather flat, and it is interspersed here and there with rocks and little hills, like the Paleveram ones, whence ample supplies of granite may be obtained.

It is further to be remarked that the projected Channel from the Palaur at Arcot, terminates in the head of the basin of the Adyar, so that water can be led by that line into these tanks.

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28.	Do. Do. Do. 1855-56	*do.* ...	1	0
29.	REPLIES TO THE COLLECTIVE MEMORANDUM ON PUBLIC WORKS IN THE MADRAS PRESIDENCY	*do.* ...	0	12
30.	REPORT ON DISTRICT ROADS FOR 1854	*do.* ...	1	4
31.	REPORT ON APPLICATIONS FOR GRANTS-IN-AID OF SCHOOLS UNCONNECTED WITH GOVERNMENT	*do.* ...	0	0
32.	REPORT OF A COMMITTEE ON A PLAN FOR CLEANSING THE DRAINS OF BLACK TOWN	*do.* ...	1	0

Printed at the Asylum Press by WM. THOMAS, and Published by H. SMITH, at the GOVERNMENT PRESS, *Fort St. George*, and sold by Messrs. PHAROAH and Co., *Mount Road.*